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# Solving Systems of Equations and Inequalities: An Algebra Unit Plan Aligned to the New York State Common Core

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## Abstract

As a response to both the implementation of the Common Core State Standards (CCSS) and a recent approval of a change by the New York State Board of Regents to allow multiple pathways for graduation, this curriculum project, which will be referred to as a unit plan throughout the paper, was designed to meet the need for more units of study that address looking for and making use of structure in Algebra. The unit plan on solving systems of equations and inequalities is aligned to the New York State Common Core Learning Standards for mathematics (NYSCCLM) and addresses looking for and making use of structure, mathematical practice standard number 7. This unit plan, which may provide a method by which Algebra teachers can continue to work toward the Common Core State Standards Initiative (CCSSI) goal of preparing students for both college and career success, was validated by a tenured teacher of Algebra.

# CHAPTER 1: PURPOSE/OVERVIEW

Mathematics is a complex subject that takes time and dedication to learn. Learning mathematics is known to be a complex task. Complex tasks have many different solutions, have real world applications, cannot be mastered in a single session, and pose a very high load on the learner's cognitive system (van Merrienboer, Kester, & Paas, 2006). Learning the literacy, theories, and processes involved in mathematics is often a daunting task for students. With that said, there are certain groups of students for whom learning mathematics is extremely complex.

One of these groups of students is those who are in an alternative education re-engagement setting. This is a population of students that really struggle with engagement, and often the placement is an alternative education setting for re-engagement. There are various types of students who make up the population of an alternative education re-engagement school. Some of the varying groups of students who are placed in the alternative education setting includes (but is not limited to) students who struggle with issues of drug use, young mothers, students on house arrest, truants, and those who struggle to engage.

Alternative education re-engagement schools support varied learners in moving along the continuum of learning so that the amount of mathematics that they can do without support increases, and what they cannot yet do decreases. There are many types of re-engagement to support students, including a shortened school day, a smaller and relaxed classroom setting, a lesser workload, and a large amount of flexibility.

Some alternative education re-engagement centers are known to be hybrid classrooms and to contain a portion of the material online. One tool used with this unit plan was Google Classroom. Google Classroom allows teachers to create assignments, make announcements, and grade student wok-all online (Google for Education, 2014). Due dates can be set, conversations can be started, and the classroom can be accessed from anywhere with an internet connection. As a free application, Google Classroom was used not only as a way to bring technology into the classroom, but to create note videos to actively engage students.

**Key Terms and Definitions**

*CCSSM* – Common Core State Standards of Mathematics are the standards adopted by numerous states in the United States, to which the unit plan is aligned

*NCTM* – National Council of Teacher of Mathematics; created the standards upon which the CCSSM were based upon

*NYSCCLSM* – New York State Common Core and Learning Standards of Mathematics address all CCSSM

*Real-world Application* – the ability to apply the math concepts to a variety of situations, possibly without prompt (EngageNY, 2012a).

*Standards* – what students should be able to understand and be able to do (CCSSI, 2012).

*TIMSS* – Trends in International Mathematics and Science Study (National Center for Education Statistics, n.d.)

# CHAPTER 2: LITERATURE REVIEW

## Common Core State Standards and the New York State Common Core and Learning Standards of Mathematics

For years, the students of the United States have been exhibiting performance far below that of other countries across the globe. The Trends in International Mathematics and Science Study (TIMSS) "provides reliable and timely data on the mathematics and science achievement of U.S. students compared to that of students in other countries" (National Center for Education Statistics (NCES), n.d.). Prior to 2015, grade 9 had not been included in the TIMSS. Grades 4 and 8, however, were included in the previous TIMMS studies, and were shown to follow a downward trend of performance relative to that of other countries (Griffin, 2013). The TIMSS data from the 2015 study shows that the United States ranked 5$^{th}$ for 9$^{th}$ grade mathematics in comparison to the other nations that completed the survey (NCES, n.d.). Based off of data from grade 8 mathematics, the performance of the United States has ranked anywhere from 19$^{th}$ to 9$^{th}$ from 1999 to 2011 relative to that of other countries (Griffin, 2013). This pattern of receiving rankings lower than other countries is one of the factors that led The Council of Chief State School Officers and the National Governors Association Center for Best Practices to develop the Common Core State Standards (CCSS) (Common Core State Standards Initiative (CCSSI), 2010) with the goal of decreasing the performance gap of the United States.

### Standards Based Education

The CCSS were built upon preexisting state standards, most often the National Council of Teachers of Mathematics (NCTM) *Standards*, (CCSSI, 2010). The NCTM *Standards*, developed in 1989, were the first set of standards in mathematics education. Before standards-based education, there were no guidelines or requirements to what ought to be taught in the classroom. Before standards existed in education, textbooks were used as the main guidelines and backbone of the class curriculum (Griffin, 2013).

The NCTM *Standards* were implemented, the standards were modified by individual states to create their own standards and assessments that aligned to the NCTM standards. In 1995, the State of New York developed the New York State Learning Standards. Built upon the NCTM standards, the New York State Learning Standards were designed to lay out expectations for content and curriculum for each grade level (New York State Education Department (NYSED), 2010). As a result, the individual state standards were used to create instructional materials and curriculum supports. Due to the fact that standards varied by state, instructional materials and curriculum supports also varied by state. This resulted in a plethora of resources that were difficult to share across states.

The CCSS were created in 2010 with the goal of having a set of national standards. As an incentive for all fifty states to adopt the national standards, Race to the Top (RTT) was created (U.S. Department of Education, 2010). In return for adopting and implementing the CCSS, states would receive monetary rewards. California, Texas, New York, and Florida all received awards between $350 million and $700 million dollars for adopting and implementing the CCSS (U.S. Department of Education, 2010). As a result, these states shared standards and were able to collaborate on objectives, curriculum, and assessments.

In addition to having a set of standards that would be shared across the fifty states, the CCSS had a goal of increasing the amount of students who are "college and career ready" (CCSSI, 2010). According to the National Governors Association Center for Best Practices (2010), the middle school standards are now rigorous and provide a rational and thorough preparation for upper level mathematics. The CCSS were designed not only to provide teachers with guidance on curriculum and instruction to succeed in upper level mathematics, but also on what they need to prepare their students with to find success in life beyond high school.

**The Shift to the CCSS**

Thus far, forty-two states-including New York State, have adopted and are fully implementing the CCSS (CCSSI, 2012). The states that have adopted and are implementing the standards have experienced the paradigm shift from the NCTM standards to the Common Core State Standards of Mathematics (CCSSM). Despite the adoption of the CCSSM, New York State has also added a portion of its own standards. Combined, the CCSSM and the additional New York State standards were created to form a document entitled the New York State Common Core Learning Standards for Mathematics (NYSCCLSM) (NYSED, 2010, 2013). The mission statement of the CCSSI (2012) is as follows:

> The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy.

The CCSSI (2012), claims that mathematically proficient students will be able to make connections between and use patterns or structures and that this standard is a skill that can be transferred to the real world. It is possible that prior to the CCSS, no standard existed to address the use of structure in mathematics. With the implementation of the CCSS, students across the nation will be taught to look for and to make use of structure and patterns within the mathematical curriculum.

**The Structure of the CCSS**

The NYSCCLSM and the CCSSM are composed of two documents, the Standards for Mathematical Content and the Standards for Mathematical Practice. While both of these have been adopted by New York State, they vary in content. The Standards for Mathematical Content contain what students should understand and be able to do, whereas the Standards for Mathematical Practice contain the methods that students should be practicing in the classroom (Griffin, 2013). Another difference between the two documents is that the Standards for Mathematical Content are grade specific while the Standards for Mathematical Practice are the same for each grade. The Standards for Mathematical Practice are composed of the following eight standards (NYSED, 2011):

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

The shift toward the CCSSM requires deep thinking and understanding for students across all content areas and all grade levels. The main goal is for teachers to be able to provide a cohesive curriculum that connects content across subject areas and grade levels (EngageNY, 2012).

The New York State Common Core Learning Standards for Mathematics (NYSCCLSM) provide a structure that can be used to create curriculum and implement standards in the mathematics classroom. In order to be considered successful, the curriculum must be designed to prepare students to be successful in college and in the workforce (CCSSI, 2010). The CCSS are organized by grade level, and build upon the standards from previous grade levels.

Although the CCSS are organized by grade level, they do not provide a timeline for the school year, learning activities, or instructional methods. Created by the New York State Education Department (NYSED), EngageNY.org has provided a document that breaks down each mathematical content standard at every grade level (NYSED, 2013). When looking at the differences between the NYSLSM and the NYSCCLSM, there are differences that are clearly visible among the mathematical content standards for each grade level. The NYSCCLSM have shifted some standards by grade level, eliminated standards, and in some instances, have created additional standards. Despite these changes, the standards have been organized to build upon one another.

**Solving Systems of Equations and Inequalities and the CCSS**

In regards to solving systems of equations and inequalities, students in eighth grade are expected to achieve the following standards from the CCSS (NYSED, 2011):

> 8.EE.8a Understand that solutions to a system of two linear equation in two variables correspond to points of intersection of their graphs;
>
> 8.EE.8b Solve systems of two linear equations in two variable algebraically;
>
> 8.EE.8c Solve real-world and mathematical problems leading to two linear equations in two variables.

Although these are eighth grade standards, solving systems of equations and inequalities in grade 9 requires these skills. Building off of the listed eighth grade standards, students in grade 9 are expected to achieve the following CCSS (NYSED, 2011):

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays;

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling;

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities;

F-IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context;

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales;

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context;

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions;

A-REI.6 Solve systems of linear equations exactly and approximately, focusing on pairs of linear equations in two variables;

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane;

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane.

Across the nation, curriculum aligned to the CCSS is being designed and implemented. Therefore, the following unit plan addresses the standards listed for grade 9 by building off of the standards listed for grade 8. The unit plan will provide lessons that incorporate Standard 7 for Mathematical

Practice: looking for and making use of structure. This unit plan may help educators in the transition to the CCSSM and meet the needs of all learners to help them find success in solving systems of equations and inequalities.

## Teaching the CCSS in a Nontraditional Setting

Teaching the NYSCCLSM in a nontraditional setting can be more challenging but can be overcome by using nontraditional teaching methods. One way this can be done is through a hybrid classroom setting that allows students easy access to the classroom via multiple outlets. For example, the use of the physical classroom, e-mail, and Google Classroom. Additionally, it is important to allow students to make connections between solving systems of equations and solving systems of inequalities. Providing application contexts where money is used provides ways for students to connect the mathematics they are learning with monetary situations. Students can easily relate to these as they are consumers and will someday become employees. Also providing different methods of solving equations and inequalities allow students flexibility in the ways in which they can present their work. This is especially important for alternative education students because of the fact they are already struggling to engage. When presented with options, students are able to choose the method by which they complete a problem, and in turn will feel more successful.

## CHAPTER 3: UNIT PLAN

The Algebra unit plan detailed below addresses the topic of solving systems of equations and inequalities. This is a ninth grade topic that builds off of some eighth grade standards. New York State began implementing the NYSCCLSM in the 2012-2013 school year, and are composed of the CCSS with a few extra standards added by the state of New York. Since this unit is intended for those within New York State, the standards listed below are from the NYSCCLSM. Within the NYSCCLSM/CCSS, there is a section titled "Creating Equations," referred to as CED, and another section titled "Reasoning with Equations and Inequalities," referred to as REI. The ninth grade Algebra unit in solving systems of equations and inequalities is aligned to the following seven standards from the CED and REI sections (NYSED, 2013):

N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays;

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling;

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities;

F-IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context;

A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales;

A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods;*

A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions;

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables;

A-REI.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line);

A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

The lesson plans presented below will use a form of the Understanding by Design (UbD) lesson format (Wiggins & McTighe, 2005). The UbD format is designed to have several stages. The first stage is clarifying desired results. In this stage, the goals and what students will understand by the end of the lesson is determined. The second stage is evidence, which lists what students will be doing and how they will be assessed. This includes homework, classwork, checks for understanding, quizzes, and tests. The third stage would usually entail learning activities implemented throughout the unit, but is excluded to meet the needs of an alternative education setting.

Lessons one through six, including notes, classwork, and quiz, are each designed to cover an eighty-minute time period. Accompanying the lessons are a review packet and end-of unit assessment. Although the main source of content is original content from the author, additional resources include New York State Common Core Mathematics Curriculum Algebra Module I (2014). Answer keys to all materials may be found in the Appendix.

**Algebra Unit Plan-Solving Systems of Equations and Inequalities**

**Algebra-Unit: Solving Systems of Equations and Inequalities-Lesson 1**

Lesson Topic: Graphing lines by plotting points Grade Level: 9

Duration: 80 minutes Teacher Name: ______________

<table>
<tr><th colspan="3">Stage 1 – Desired Results</th></tr>
<tr><td rowspan="3">External Standards(s):<br><br>A-REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).</td><td colspan="2">Essential Question:<br><br>How can I find the solution to a system of equations by looking at a graph?</td></tr>
<tr><td colspan="2">Understanding Goal:<br><br>Students will understand that:<ul><li>The graph of the line ax + by = c is a visual representation of the solution set to the equation ax + by = c</li></ul></td></tr>
<tr><td>Skills: students will be able to…<ul><li>Recognize and identify solutions to two-variable equations</li><li>Represent the solution set graphically</li><li>Create two-variable equations to represent a situation</li></ul></td><td>Content: (facts, vocabulary, knowledge)<ul><li>Linear equation</li><li>Coordinate plane</li><li>Variables</li><li>Solution set</li></ul></td></tr>
<tr><th colspan="3">Stage 2 – Assessment Evidence</th></tr>
<tr><td>Performance Task(s):<ul><li>Notes p. 1-3</li></ul></td><td colspan="2">Other Evidence: (classwork, quizzes)<ul><li>Graphs plotted in Guided Practice section</li></ul></td></tr>
</table>

**Algebra**

Unit 3 – Lesson 1 – Graphing Lines By Plotting Points

Name: ______________________________ Date:______________

## Lesson Objectives:

- I can recognize and identify solutions to two-variable equations.
- I can represent the solution set graphically.
- I can create two variable equations to represent a situation.
- I understand that the graph of the line $ax + by = c$ is a visual representation of the solution set to the equation $ax + by = c$.

## Accessing Prior Knowledge:

a. Circle all the ordered pairs $(x, y)$ that are solutions to the equation $-\frac{1}{2}x = y - 8$.

$(0,8)$ $(2,3)$ $(-2,9)$ $(0,0)$ $(1,-6)$

$(-4,10)$ $(0,-10)$ $(3,4)$ $(2,7)$ $(-4,-1)$

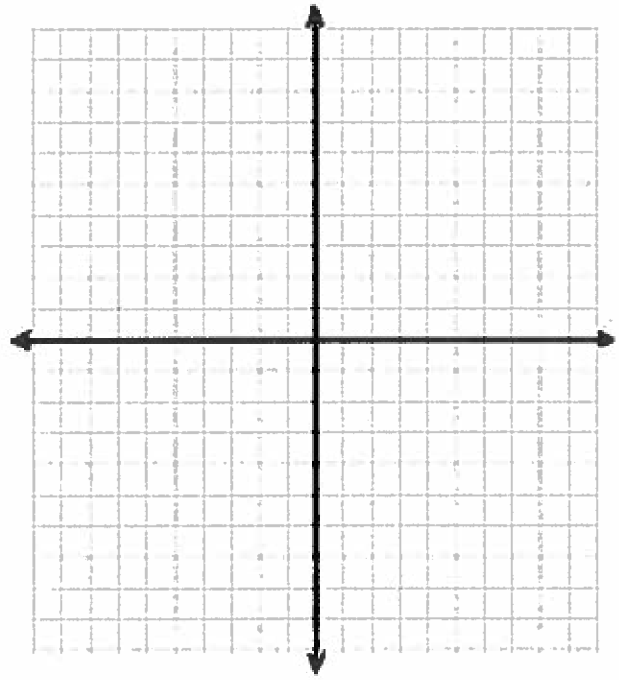
b. How did you decide whether or not an ordered pair was a solution to the equation?

c. Now, find 5 more solutions where one or more variables are **negative numbers** or **non-integer values.**

## Concept Development:

### Exercise 1

a) How many ordered pairs $(x, y)$ will be in the solution set of the equation $-\frac{1}{2}x = y - 8$?

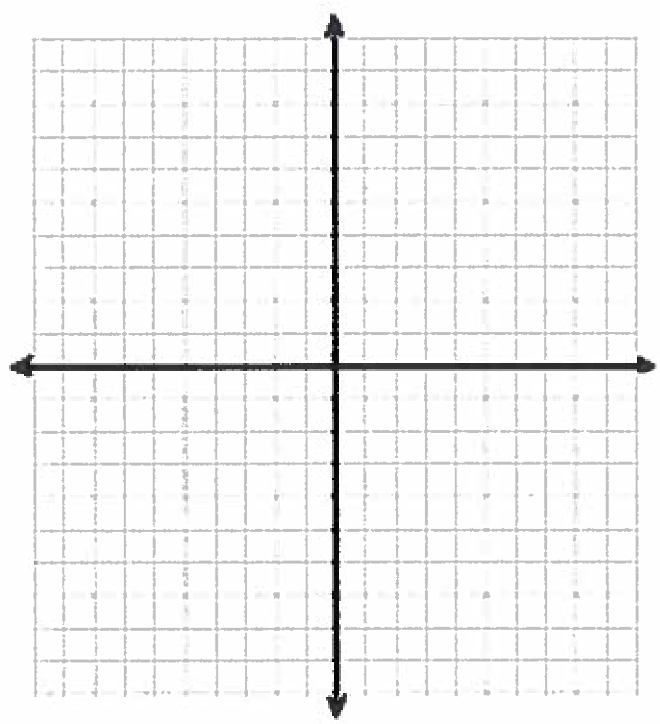


b) Create a visual representation of the solution set by plotting each solution as a point $(x, y)$ in the coordinate plane.

c) Why does it make sense to represent the solution to the equation $-\frac{1}{2}x = y - 8$ as a line in the coordinate plane?

### Exercise 2

The sum of two numbers is 20. What are the numbers?



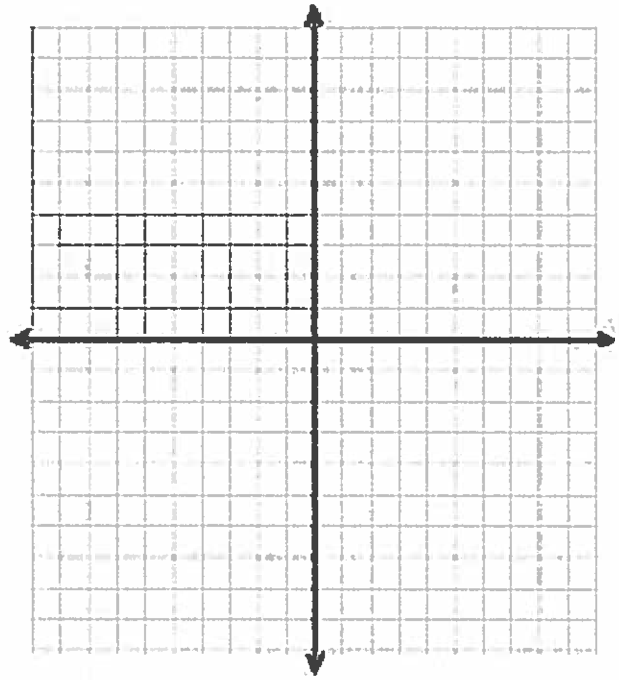
a) Create an equation using two variables to represent this situation. What is the meaning of each variable?

b) List at least 6 solutions to the equation you created in part (a).

c) Create a graph that represents the solution set to the equation.

## Guided Practice:

**Exercise 3**



Kelsee had a container with 20 markers of her favorite colors, blue and purple. How many markers of each color did she have in the container?

a) Create an equation using two variables to represent this situation. What is the meaning of each variable?

b) List at least 3 solutions to the equation you created in part (a).

c) Create a graph that represents the solution set to the equation.

d) Compare your solutions to exercises 2 and 3. How are they alike? How are they different?

| |
|---|
| An ordered pair is a ____________________ to a two variable equation. When the ordered pair is plugged into the equation, it will make the number sentence ________. |

**Algebra-Unit: Solving Systems of Equations and Inequalities-Lesson 2**

Lesson Topic: Introduction to graphing piece-wise, quadratic, and exponential functions

Grade Level: 9

Duration: 80 minutes

Teacher Name: ______________

<table>
<tr><th colspan="3">Stage 1 – Desired Results</th></tr>
<tr><td rowspan="3">External Standards(s):<ul><li>N-Q.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</li><li>N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.</li><li>N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</li></ul></td><td colspan="2">Essential Question:<br>Where do we see algebraic functions in everyday life?</td></tr>
<tr><td colspan="2">Understanding Goal:<br>Students will understand that:<ul><li>Real life examples can be represented by each of the four types of functions</li></ul></td></tr>
<tr><td>Skills: students will be able to…<ul><li>Sketch the basic functions necessary for success in algebra this year</li><li>Distinguish between piecewise, linear, quadratic, and exponential functions</li></ul></td><td>Content: (facts, vocabulary, knowledge)<ul><li>Function</li><li>Piecewise</li><li>Linear</li><li>Quadratic</li><li>Exponential</li></ul></td></tr>
</table>

<table>
<tr><th colspan="2">Stage 2 – Assessment Evidence</th></tr>
<tr><td>Performance Task(s):<ul><li>Notes, p. 1-7</li></ul></td><td>Other Evidence: (classwork, quizzes)<ul><li>3.2/3.3 Classwork (completed after lesson 3)</li><li>3.2/3.3 Quiz (taken after lesson 3)</li></ul></td></tr>
</table>

# Algebra
## Unit 3 – Lesson 2 – Introduction to Graphing Functions

Name: ______________________________ Date: ________________

**Lesson Objectives:**

- I can sketch the basic functions necessary for success in algebra this year.
- I can distinguish between piecewise, linear, quadratic, and exponential functions.
- I recognize that real life examples can be represented by of each type of function.

**Concept Development:**

There are four main types of functions that we will be discussing this year:

1)
2)
3)
4)

**<u>Linear Functions</u>**

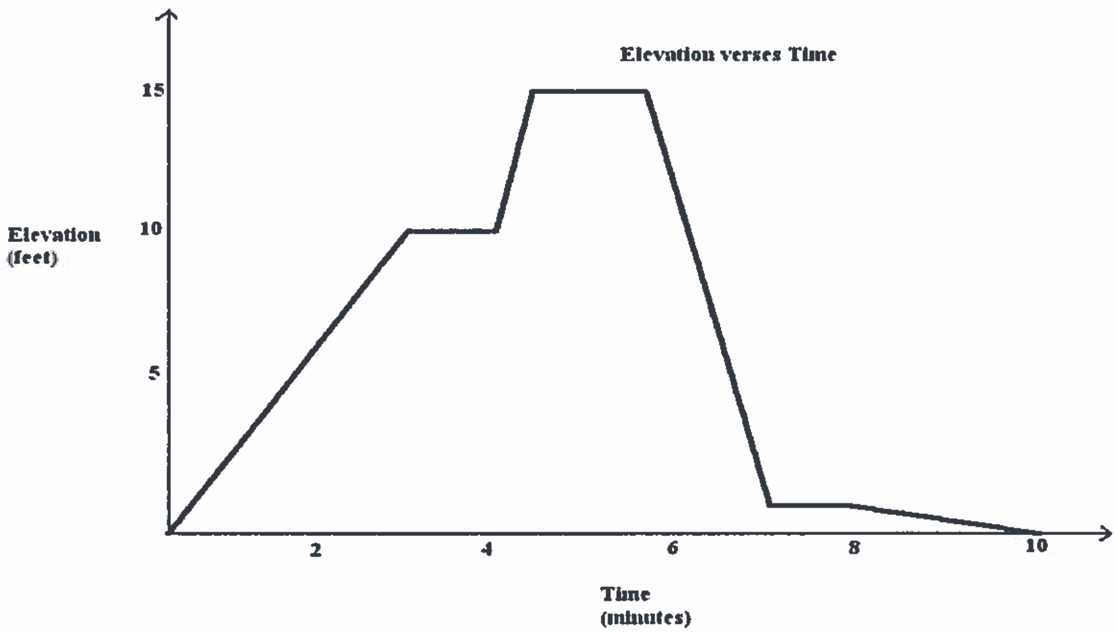
Linear functions are functions that produce ____________________. A line is generally in the form __________________________. An example of a line is drawn below.

In a linear function, the rate of change is ______________________________.

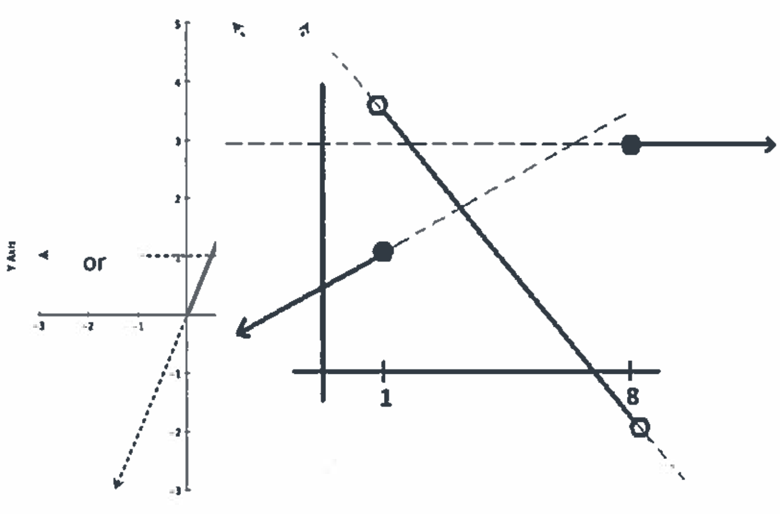
Real life examples of linear functions:

## Piecewise Functions

Here is an elevation-versus-time graph of a person's motion. Can we describe what the person might have been doing?




**PIECEWISE-DEFINED LINEAR FUNCTION**: Given non-overlapping intervals on the real number line, a *(real) piecewise linear function* is a function from the union of the intervals on the real number line that is defined by linear functions on each interval.



✓ **Self Assessment:**

Rate your level of understanding:

1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ____________________________________________

**Guided Practice: (Real life example)**

2. A man is climbing down a ladder that is 10 feet high. At time 0 seconds, he is 10 feet above the ground. At 6 seconds, he is at 3 feet above the ground. Between the 6 second and 8.5 second marks, he stops to drink some water on the step that is 3 feet off the ground. After drinking the water, he takes 1.5 seconds to descend the rest of the ladder to the ground. He then walks into the kitchen.

   a) Draw your own graph for this graphing story. Use straight line segments in your graph to model the elevation of the man over different time intervals. Label your $x$-axis and $y$-axis appropriately and give a title for your graph.

   b) Your picture is an example of a graph of a piecewise linear function! Each linear function is defined over an interval of time. These intervals of time are represented on the horizontal axis (seconds). List those time intervals.

   c) In your graph in part (a), what does a **horizontal** line segment represent in the graphing story?

d) Suppose the ladder is descending into the basement of the apartment. The top of the ladder is at ground level (0 feet) and the base at the ladder is 10 feet below ground level. How would your graph change in observing the man following the same motion descending the ladder?

e) What is his average rate of descent between time 0 seconds and time 6 seconds? What was his average rate of descent between time 8.5 seconds and time 10 seconds? Over which interval does he descend faster? Describe how your graph in part a can also be used to find the interval during which he is descending the fastest.

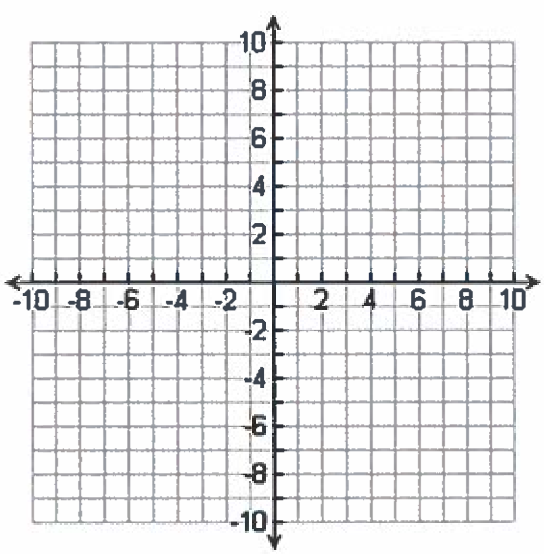
## Quadratic Functions

Quadratic functions are functions that produce ______________________. A parabola is generally in the form ____________________________. An example of a line is drawn below.

The table below gives the area of a square with sides of whole number lengths. Have students plot the points in the table on a graph and draw the curve that goes through the points.

| *Side* (cm) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| *Area* ($cm^2$) | 0 | 1 | 4 | 9 | 16 |

On the same graph, reflect the curve across the $y$-axis. This graph is an example of a "graph of a quadratic function."



In a quadratic function, the rate of change is ______________________________.

Real life examples of quadratic functions:

✓ **Self Assessment:**

Rate your level of understanding:

1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ____________________________________________________________

**Exponential Functions**

Exponential functions are functions that produce ________________________. An exponential graph is generally in the form _________________________. A real life example of an exponential graph is drawn below.

http://www.youtube.com/watch?v=KxB43PxasGA

1. What is your best guess about the number of people who would receive Pay It Forward good deeds at the tenth stage?

2. How many people would receive a Pay It Forward good deed at each of the next several stages?
   a. Make a table that shows the number of people who will receive good deeds at each of the next seven stages of the Pay It Forward process.

| Stage of Process | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Good Deeds | 3 | | | | | | | | | |

   b. Now plot the data on a graph. Make sure you have accurate axes labels and scales.

3. How does the number of good deeds at each stage grow as the tree progresses? How is that pattern change shown in the plot of the data?

4. Write a rule relating Number of Good Deeds (N) to the Stage of Process (x). This rule could be used to model the Pay It Forward Process in which each person does good deeds for three other new people.

**Lesson Summary:**

Linear functions look like:

Linear functions are called ________________, and are in the form ____________.

Piecewise linear functions look like:

Piecewise linear functions are called ________________, and are in the form ____________.

Quadratic functions look like:

Quadratic functions are called ________________, and are in the form __________________.

Exponential functions look like:

Exponential functions are called ________________, and are in the form _____________________.

**Algebra-Unit: Solving Systems of Equations and Inequalities-Lesson 3**

Lesson Topic: Solving linear systems by graphing — Grade Level: 9

Duration: 80 minutes — Teacher Name: _______________

<table>
<tr><th colspan="3">Stage 1 – Desired Results</th></tr>
<tr><td rowspan="3">External Standards(s):<ul><li>F-IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.</li><li>A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</li><li>A-REI.6 Solve systems of linear equations exactly and approximately, focusing on pairs of linear equations in two variables</li></ul></td><td colspan="2">Essential Question:<br>What does the solution to a system of linear equations mean in a real-life context?</td></tr>
<tr><td colspan="2">Understanding Goal:<br>Students will understand that:<ul><li>Real life problems can be solved by graphing linear systems</li></ul></td></tr>
<tr><td>Skills: students will be able to…<ul><li>Graph multiple linear equations on the same graph</li><li>Identify a solution to a graph as an intersection point of the two graphs</li><li>Solve real life problems by graphing linear systems</li></ul></td><td>Content: (facts, vocabulary, knowledge)<ul><li>Variables</li><li>Linear equations</li><li>Coordinate axes</li><li>Scales</li><li>Functions</li><li>Solution</li><li>Intersection</li></ul></td></tr>
<tr><th colspan="3">Stage 2 – Assessment Evidence</th></tr>
<tr><td>Performance Task(s):<ul><li>Notes p. 1-6</li></ul></td><td colspan="2">Other Evidence: (classwork, quizzes)<ul><li>3.2/3.3 Classwork</li><li>3.2/3.3 Quiz</li></ul></td></tr>
</table>

# Algebra

## Unit 3 – Lesson 3 – Solving Linear Systems by Graphing

Name: ______________________________ Date: ________________

**Lesson Objectives:**

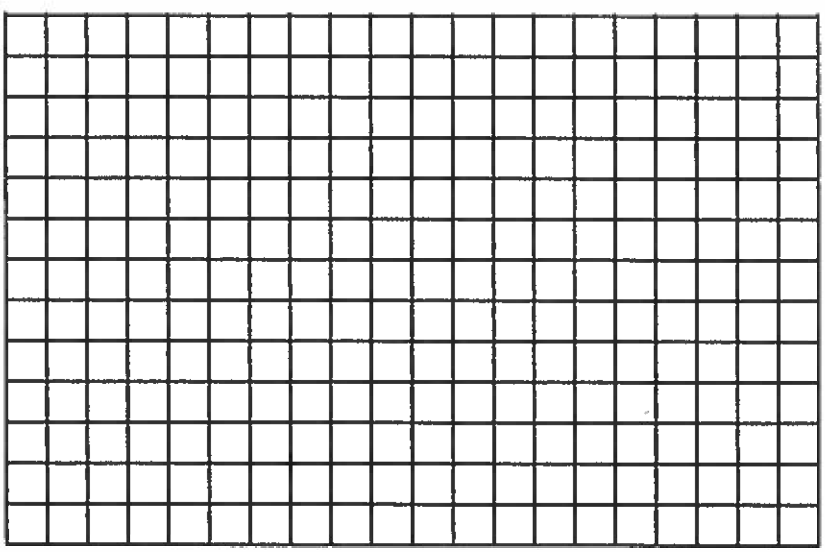
- I can graph multiple linear equations on the same graph
- I can identify a solution to a graph as an intersection point of the two graphs
- I can solve real life problems by graphing linear systems

**Concept Development:**

**Example 1:**

*John and Jessica are brother and sister. Their bedrooms are at the opposite ends of the upstairs hallway, 30 feet apart. Each starting at their own door, they walk at a steady pace towards each other and stop when they meet.*

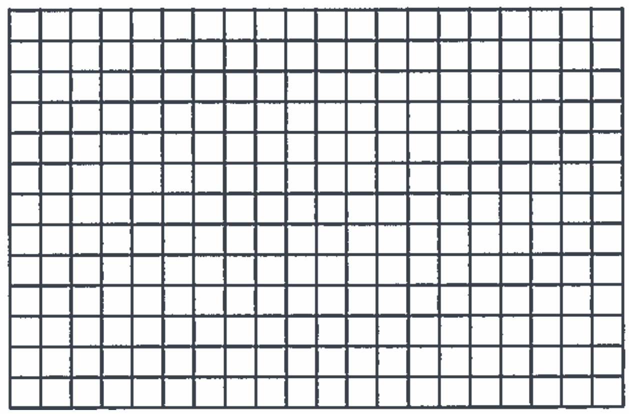
Jessica walks at a pace of 3 feet per second and John walks at a pace of 5 feet per second. What would their graphing stories look like if we put them on the **same** graph? What would happen on the graph when John and Jessica meet in the hallway? Sketch a graph that shows their distance from Jessica's door.



**Example 2:**

*Tim starts at the bottom of a staircase and walks up it at a constant rate. His elevation increases by two feet every second. Just as Tim starts walking up the stairs, Keisha starts at the top of the same 40 foot staircase and begins running down the stairs at a constant rate of eight feet per second.*

a. Sketch two graphs on the same set of elevation-versus-time axes to represent Tim's and Keisha's motions.



b. What are the coordinates of the point of intersection of the two graphs? At what time do Tim and Kiesha pass each other?

c. Write down the equation of the line that represents Tim's motion as he moves up the stairs and the equation of the line that represents Kiesha's motion as she moves down the stairs. Verify that the coordinates that you found in part (b) work for the equations that you wrote for part (c).

✓ **Self Assessment:**

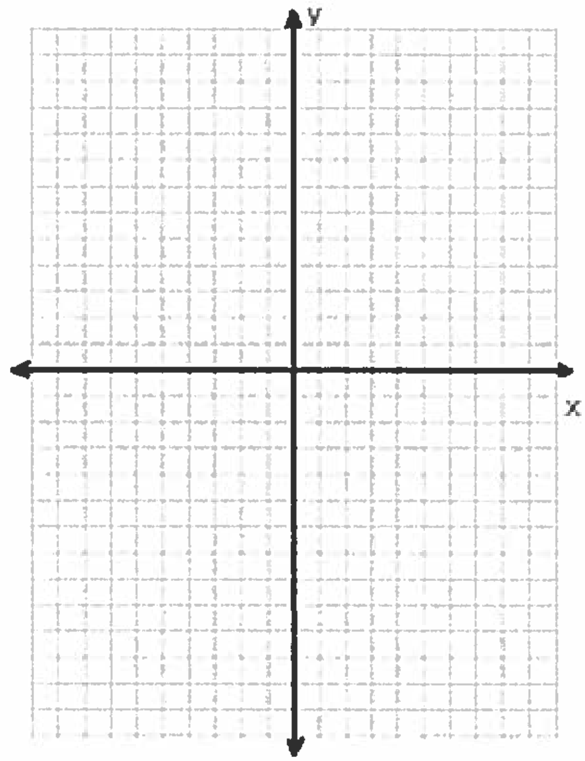
<u>Rate your level of understanding:</u>

1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ______________________________________________

**Example 3:**

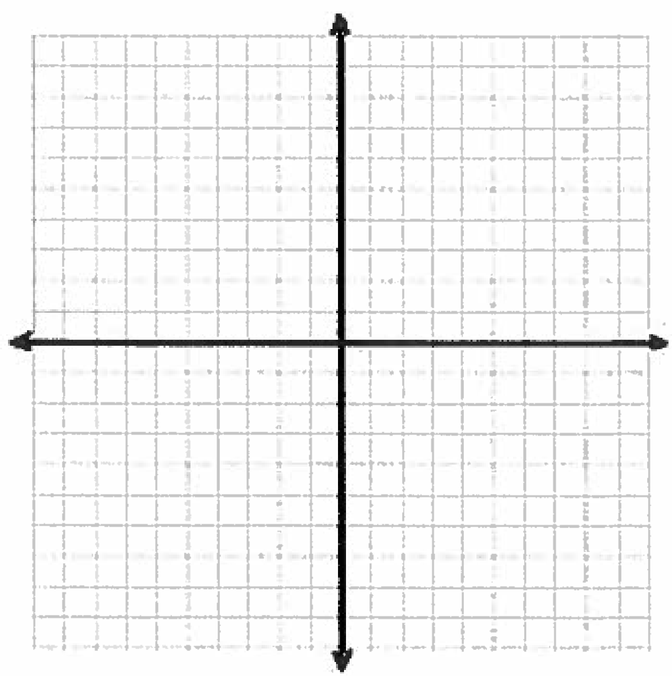
Solve the following system of equations graphically.




$$\begin{cases} y = 2x + 1 \\ x + y = 7 \end{cases}$$

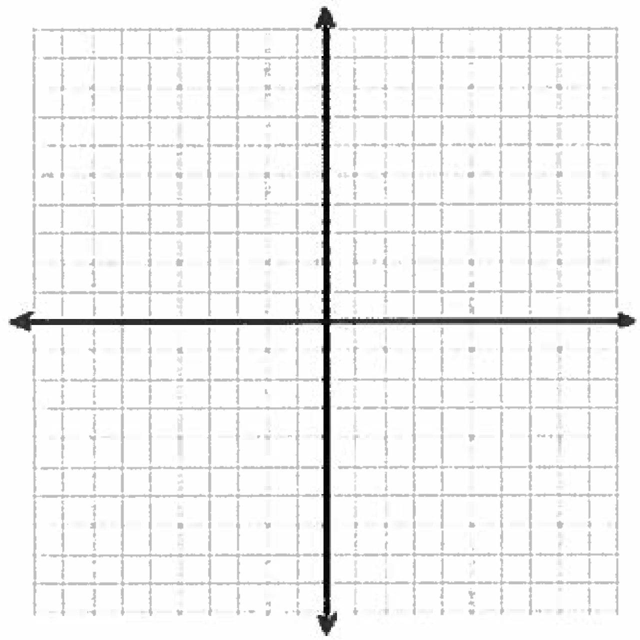
Solve the system by graphing.

$$\begin{cases} y = 4x - 1 \\ y = -\frac{1}{2}x + 8 \end{cases}$$

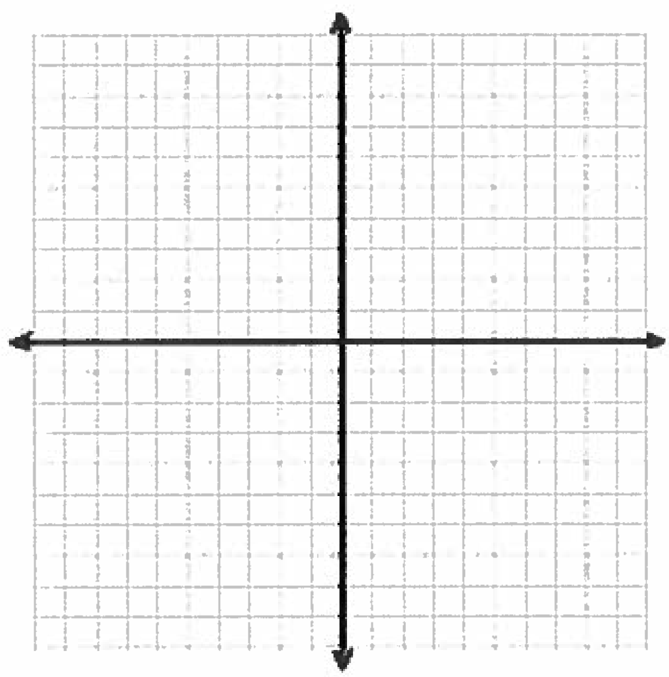


## Guided Practice

1. $\begin{cases} 2x + y = 4 \\ 2x + 3y = 8 \end{cases}$



2. $\begin{cases} 3x + y = 5 \\ 3x + y = 8 \end{cases}$



✓ **Self Assessment:**

<u>Rate your level of understanding:</u>

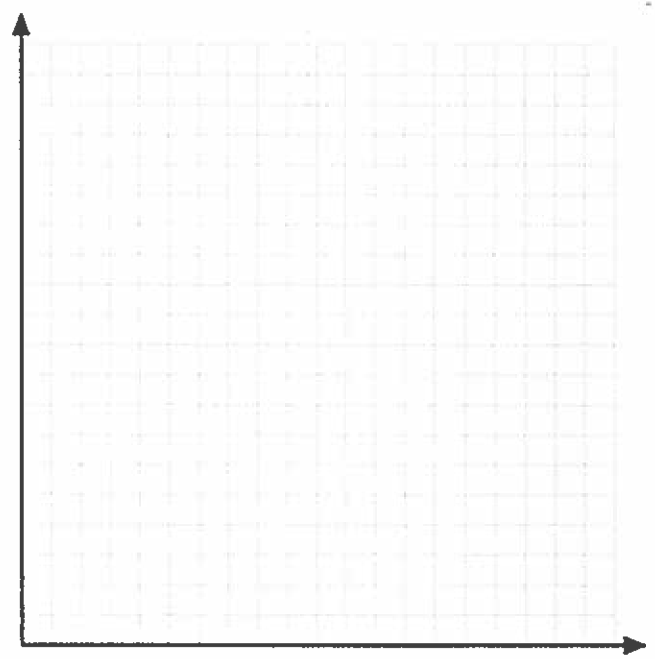
1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ______________________________________________

**Guided Practice**

b. At the carnival, there is a game called the ring toss. If you toss the ring over the neck of a bottle, you win a prize. The cost is 3 throws for $1, but if have you a wristband, you get 6 throws for $1. The wristband costs $10.

   i. Write two equations for the game in terms of the number of throws purchased – one with the wristband and one without the wristband.



   ii. Graph the two equations from part (a) on the same graph. Be sure to label the axes and use an appropriate scale.

   iii. Does it make sense to buy the wristband? Explain your answer.

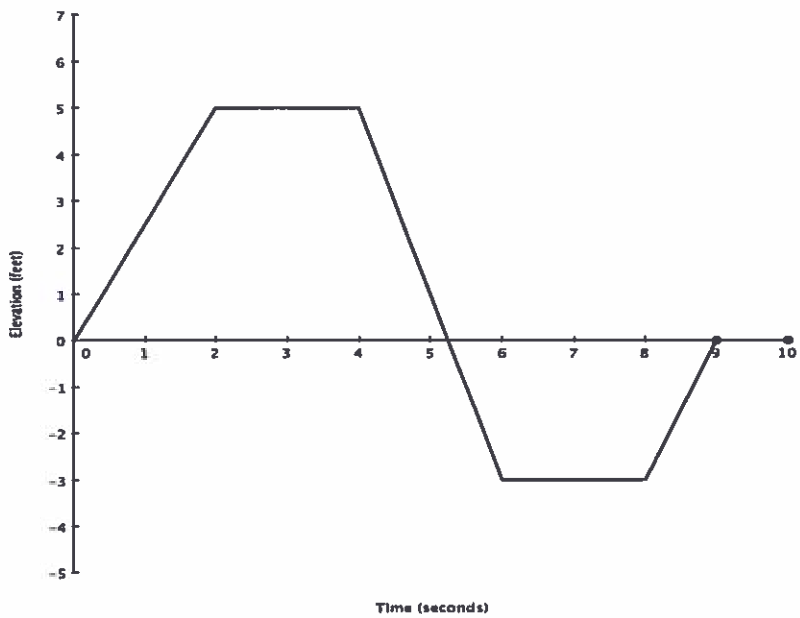
The ______________________________ of the graphs of the two equations is the ordered pair that is a solution to **BOTH** equations.

In other words, this is where the distance or elevation of both equations is equal.

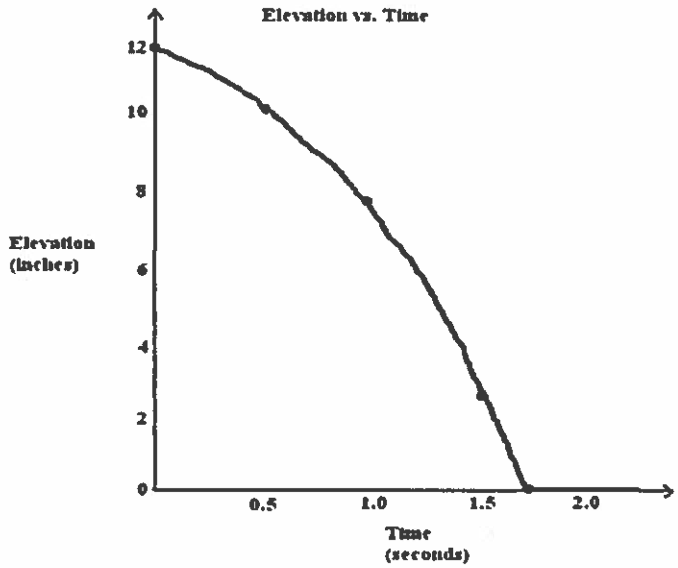
Name: ______________________________ Date:________________________

CW 3.2/3.3

1. Make up an elevation-versus-time graphing story for the following graph:



2. Below is an elevation (in inches) versus time (in seconds) graph of a ball rolling down a ramp.




a. From about 1.7 seconds onwards, the graph is a horizontal (flat) line. If Calvin puts his foot on the ball at 2 seconds to stop the ball from rolling, how will the graph change?

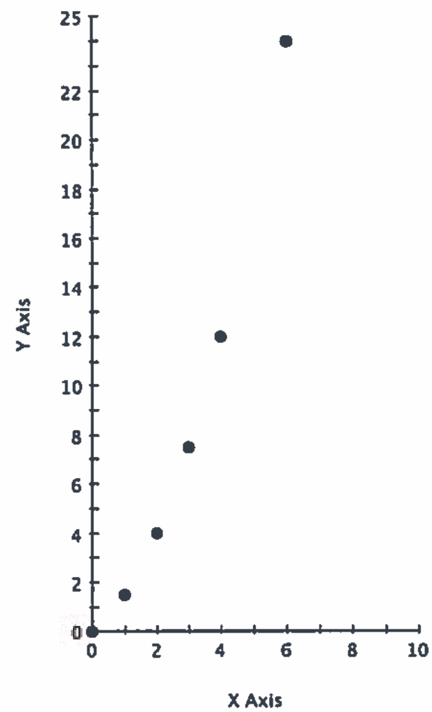
b. Estimate the change in elevation (in inches) of the ball from 0 seconds to 0.5 seconds. Also estimate the change in elevation between 1.0 seconds and 1.5 seconds.

c. At what point is the speed of the ball the fastest? Near the top of the ramp at the beginning of its journey or near the bottom of the ramp at the end of its journey?

3. Use the table below to answer the following questions.

   a. The points in this table (except when $x$ is 5 ) are plotted in the form $(x, y)$ on the graph below.

| $x$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| $y$ | 0 | 3/2 | 4 | 15/2 | 12 | | 24 |

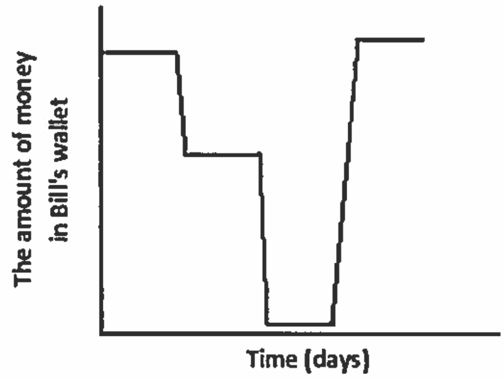



   b. The $y$-values in the table follow a pattern. This pattern can be found by computing the differences between $y$-values. Find the pattern and use it to find the $y$-value when $x$ is 5.

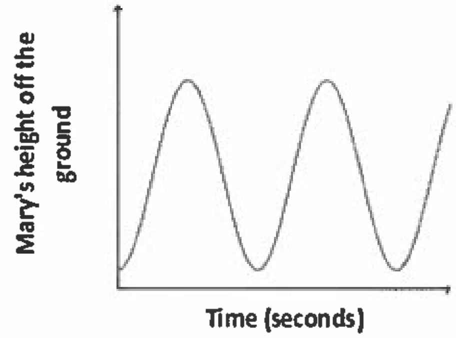
   c. Plot the point you found in part (b). Now draw a curve through the points in your graph. Does the graph go through the point you plotted?

4. Create a story to match each graph below:

a)




b)




5. Consider the following story about skydiving:

   Dana gets into an airplane and waits patiently for 2 minutes before it takes off. The airplane climbs to 9,000 feet over the next 15 minutes. After 2 minutes at that constant elevation, Dana jumps and free falls for 45 seconds until she reaches a height of 5,000 feet. After deploying her chute, she slowly glides back to the ground. After 7 minutes, Dana lands gently on the ground.

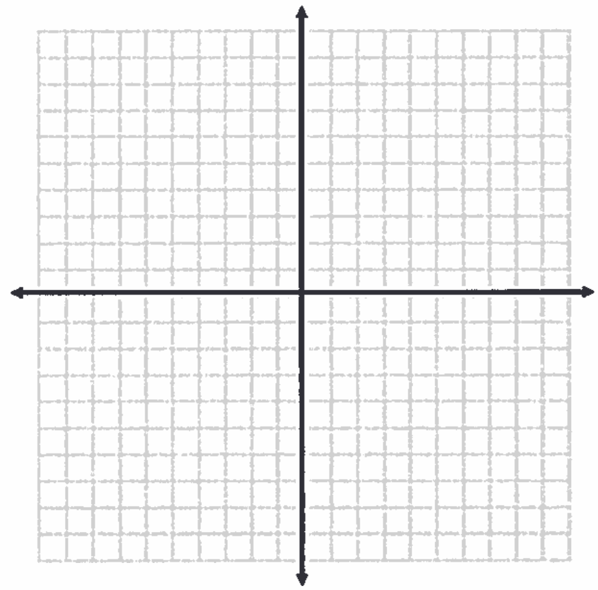
   Draw an elevation versus time graph to represent Dana's elevation with respect to time. Label both axes with an appropriate scale.

Name: ______________________________ Quiz 3.2/3.3 A

Solve the system of linear equations graphically. Be sure to state your solution in coordinate form.

$2x + y = 6$

$x - 3y = -11$

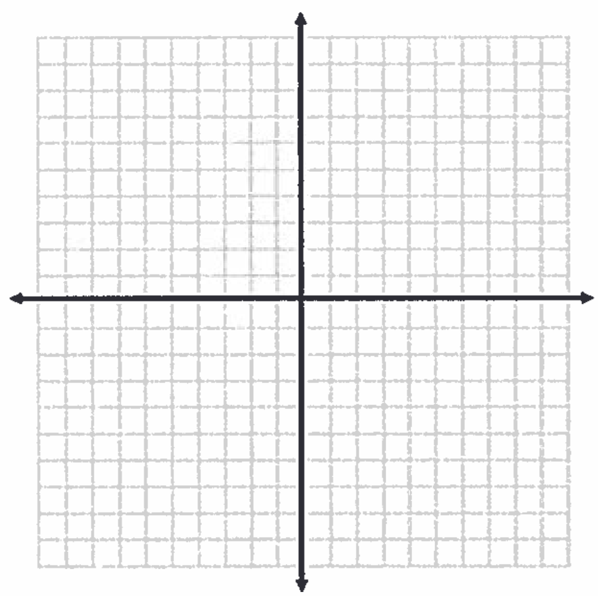


Name: ______________________________ Quiz 3.2/3.3 B

Solve the system of linear equations graphically. Be sure to state your solution in coordinate form.

$2x + 3y = 7$

$x - y = 1$



**Algebra-Unit: Solving Systems of Equations and Inequalities-Lesson 4**

Lesson Topic: Solving linear systems algebraically by using substitution and elimination

Grade Level: 9

Duration: 80 minutes

Teacher Name: ______________

<table>
<tr><th colspan="3">Stage 1 – Desired Results</th></tr>
<tr><td rowspan="3">External Standards(s):<ul><li>A-REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions</li><li>A-REI.6 Solve systems of linear equations exactly and approximately, focusing on pairs of linear equations in two variables</li></ul></td><td colspan="2">Essential Question:<br>How do I apply the methods of substitution and elimination to get the solution to a system of equations?<br>Will I get the same solution with either method of solving?</td></tr>
<tr><td colspan="2">Understanding Goal:<br>Students will understand that:<ul><li>A solution to a linear system is either a point, infinitely many points, or no solution.</li></ul></td></tr>
<tr><td>Skills: students will be able to…<ul><li>Solve linear systems using the substitution method.</li><li>Solve linear systems using the elimination method.</li></ul></td><td>Content: (facts, vocabulary, knowledge)<ul><li>Solution</li><li>Linear system</li><li>Infinite</li><li>Substitution</li><li>Elimination</li><li>Variable</li><li>Equation</li></ul></td></tr>
<tr><th colspan="3">Stage 2 – Assessment Evidence</th></tr>
<tr><td>Performance Task(s):<ul><li>Notes p. 1-5</li></ul></td><td colspan="2">Other Evidence: (classwork, quizzes)<ul><li>3.4 Classwork</li><li>3.4 Quiz</li></ul></td></tr>
</table>

# Algebra

## Unit 3 – Lesson 4 – Solving Linear Systems Algebraically

Name: ______________________________ Date: ________________

**Lesson Objectives:**

- I can solve linear systems using the substitution method
- I can solve linear systems using the elimination method
- I understand that a solution to a linear system is a point, infinitely many points, or no solution.

**Concept Development:**

When we multiply both or one equation by a constant, we are using an algebraic method of solving known as **elimination**. The basic idea of elimination is that when we multiply both sides of the equation by a constant, the equation actually remains the same. We use this to help us to eliminate one variable, allowing us to solve the equation that is left.

Solve this system of linear equations algebraically.

| ORIGINAL SYSTEM | NEW SYSTEM | SOLUTION |
|---|---|---|
| $2x + y = 6$<br>$x - 3y = -11$ | | |

**Exercise 1:**

Use **elimination** to create a new system of equations with the same solution as the original that eliminates variable $y$ from one equation, then determine the solution.

| ORIGINAL SYSTEM | NEW SYSTEM | SOLUTION |
|---|---|---|
| $2x + 3y = 7$<br>$x - y = 1$ | | |

**Exercise 2:**

Use **elimination** to create a new system of equations with the same solution as the original that eliminates variable $x$ from one equation, then determine the solution.

| ORIGINAL SYSTEM | NEW SYSTEM | SOLUTION |
|---|---|---|
| $2x + 3y = 7$<br>$x - y = 1$ | | |

## →What do you notice about the solutions to exercises 1 and 2?

**Exercise 3:**

Use **elimination** to create a new system of equations with the same solution as the original that eliminates variable $x$ from one equation, then determine the solution.

| ORIGINAL SYSTEM | NEW SYSTEM | SOLUTION |
|---|---|---|
| $5x - 2y = 7$<br>$2x + 3y = 18$ | | |

✓ **Self Assessment:**

Rate your level of understanding:

1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ______________________________________________

Another method of solving linear systems is through a method known as **substitution**. In substitution, you simply replace an expression with one that is equivalent to help you to solve for the missing variables.

In order for substitution to be effective, you must have one equation set equal to x or y. In other words, x or y must be ______________________________.

**Example:**

Solve the following system of equations by substitution.

$$\begin{cases} y = 2x + 1 \\ x - y = 7 \end{cases}$$

**Guided Practice**

1. $\begin{cases} y = 4x - 1 \\ y = -\frac{1}{2}x + 8 \end{cases}$

2. $\begin{cases} 2x + y = 4 \\ 2x + 3y = 9 \end{cases}$

**Word Problems:**

1. Rick and Anita are comparing bank accounts. Rick says, "The sum of your bank account and twice mine is 361 dollars." Anita replies, "The sum of your bank account and twice mine is 362 dollars." Find the amount in each of their bank accounts.

2. A cafeteria serves 2 types of chocolate milk: one with 60% milk and one with 75% milk. DeVaughn wants 120 ml of chocolate milk with 70% milk. How many ml of each type of chocolate milk does he need to mix?

3. Paul has two part time jobs. At one job, he works as a janitor and makes \$10 per hour. At the second job, he works as a bank teller and makes \$15 per hour. One week he worked 40 hours and made \$475. How many hours did he work at each job?

✓ **Self Assessment:**

<u>Rate your level of understanding:</u>

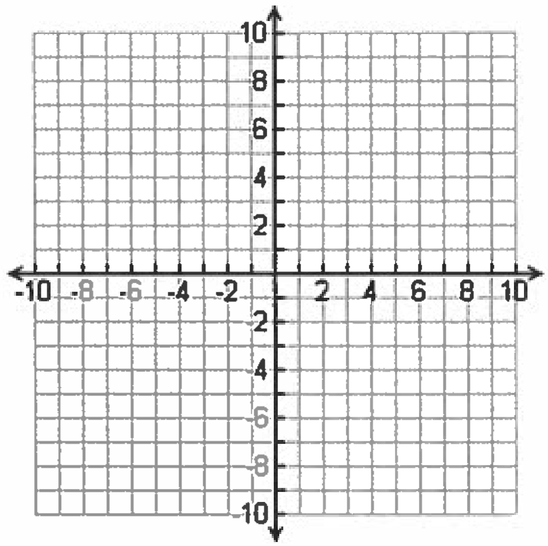
1 – confused  2 – somewhat understand it  3 – completely understand it

Questions?: ______________________________________________

Name: ______________________________ Date:____________________

CW 3.4

1. a) Solve the system of equations: $\begin{cases} y = \frac{1}{4}x \\ y = -x + 5 \end{cases}$ by graphing.




b) Solve the system above using the substitution method.

2. Solve each system of equations by elimination.

a) $2x + y = 25$
$4x + 3y = 9$

b) $3x + 2y = 4$
$4x + 7y = 1$

3. Solve the following using substitution.

$$4x + 3y = 9$$
$$2x + y = 25$$

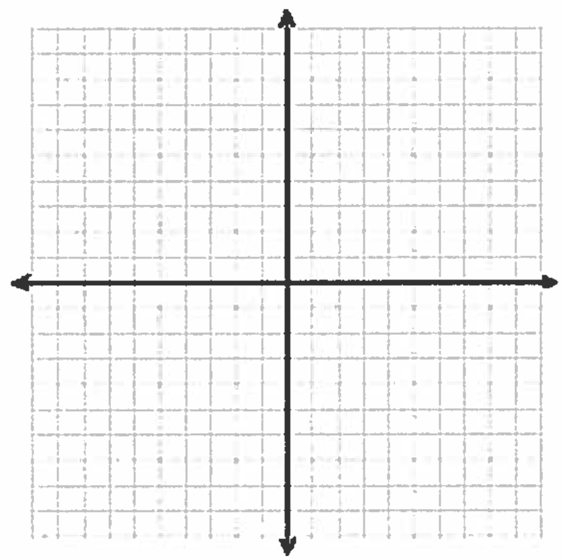
4. A chemist has two solutions: a 50% ether solution and an 80% ether solution. She wants 100 ml of a 70% ether solution. How many ml of each solution does she need to mix?

5. Kenzie has two part time jobs. At one job, she babysits for a local family and makes \$8 per hour. At a grocery store, she works as a cashier and makes \$12 per hour. One week she worked 30 hours and made \$268. How many hours did Kenzie work at each job?

6. A grocery store sells caramel syrup for \$10 per pound and chocolate syrup for \$14 per pound. If they decide to make a 150-lb. blend of the two syrups and sell it for \$11 per pound, how much of each type of syrup should be used?

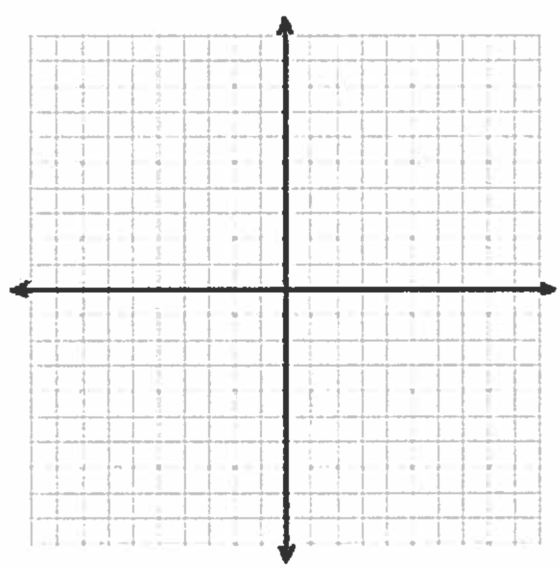
Name:________________________________ 3.4 Quiz A

Solve the following system of equations by graphing. $\begin{cases} x - 2y = 4 \\ x + 3y = 9 \end{cases}$



Name:________________________________ 3.4 Quiz B

Solve the following system of equations by graphing $\begin{cases} 3x - y = 8 \\ x + 2y = 5 \end{cases}$



**Algebra-Unit: Solving Systems of Equations and Inequalities-Lesson 5**

Lesson Topic: Graphing linear inequalities on the xy-plane, solving systems of linear inequalities by graphing

Grade Level: 9

Duration: 80 minutes

Teacher Name: _______________

<table>
<tr><th colspan="3">Stage 1 – Desired Results</th></tr>
<tr><td rowspan="3">External Standards(s):<br>• A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane</td><td colspan="2">Essential Question:<br>How does graphing equations relate to graphing inequalities?</td></tr>
<tr><td colspan="2">Understanding Goal:<br>Students will understand that:<br>• The shaded region represents all possible solutions to a problem.</td></tr>
<tr><td>Skills: students will be able to…<br>• Graph linear inequalities.<br>• Graph systems of linear inequalities.</td><td>Content: (facts, vocabulary, knowledge)<br>• Linear<br>• Inequality<br>• Ordered pair<br>• System</td></tr>
</table>

<table>
<tr><th colspan="2">Stage 2 – Assessment Evidence</th></tr>
<tr><td>Performance Task(s):<br>• Notes p. 1-5</td><td>Other Evidence: (classwork, quizzes)<br>• Classwork 3.5<br>• Quiz 3.5</td></tr>
</table>

# Algebra

## Unit 3 – Lesson 5 – Solving Linear Inequalities

Name: ______________________________ Date: ________________

**Lesson Objectives:**

- I can graph linear inequalities
- I can graph systems of linear inequalities
- I understand that the shaded region represents all possible solutions to a problem

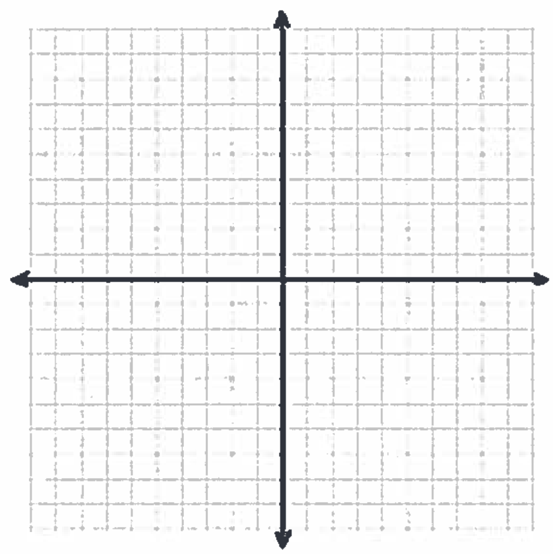
**Accessing Prior Knowledge:**

a. **Circle** each ordered pair $(x, y)$ that is a solution to the equation $-\frac{1}{2}x = y - 8$.

**Box** in each ordered pair (x, y) that is a solution to the inequality $-\frac{1}{2}x \geq y - 8$.

(0,8) (2, 3) (−2,9) (0,0) (1, −6)

(−4,10) (0, −10) (3,4) (2,7) (−4, −1)



b. Plot the points above that are circled with a dot.

Plot the points above that are boxed in with an x.

c. Connect the points that are dots. You should notice that a line is created. What do you notice about the location of all of the points plotted with an x?

**Concept Development:**

In general, when you are graphing linear inequalities, you need to follow the following steps:

1) Graph the equation as if the symbol is =, not an inequality symbol.
2) Decide whether the line should be dotted (this is true if the inequality sign is < or >) or solid (this is true if the inequality sign is ≥ or ≤)
3) Test a point. Generally we test (0,0). If the point makes the inequality true, shade in that direction. If the point makes the inequality false, shade away from that direction.

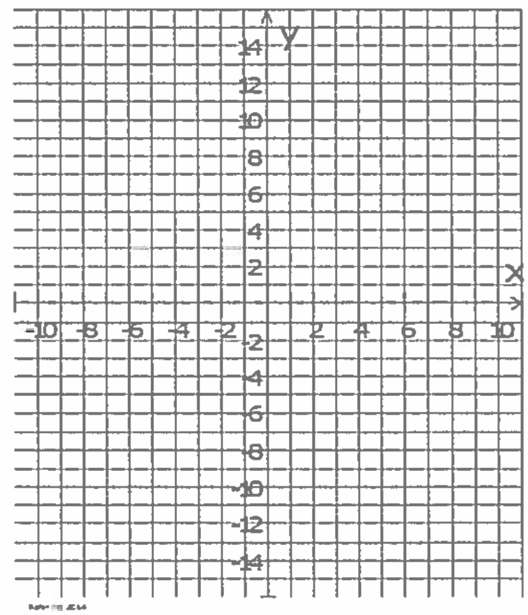
Plot the solution sets to the following equations and inequalities:

1. $x - y < 10$

a) Graph the line x – y = 10

b) Is the line going to be dotted or solid??

c) Test the point (0,0). If it is in the solution set, then shade in That direction.




✓ **Self Assessment:**

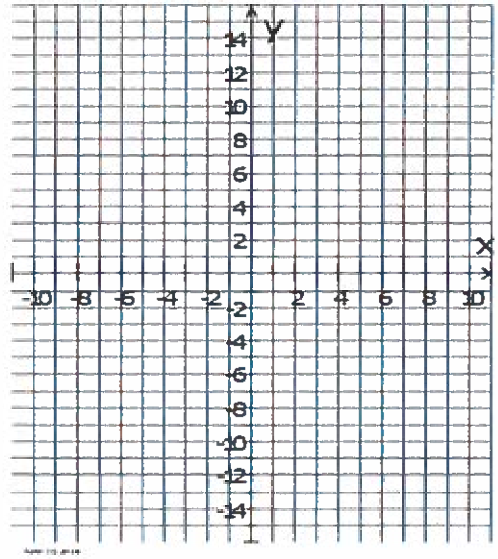
Rate your level of understanding:

1 – confused 2 – somewhat understand it 3 – completely understand it

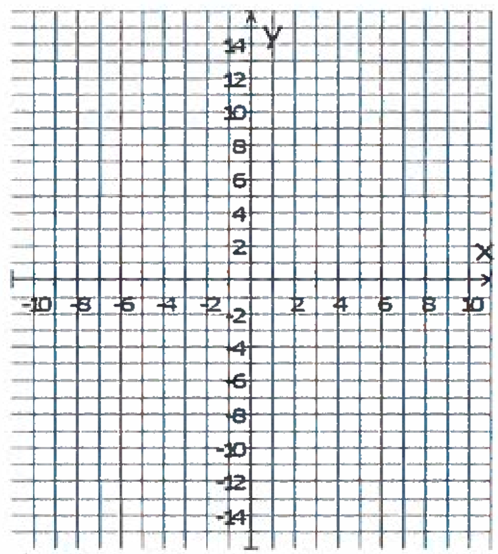
Questions?: ______________________________________________

**Guided Practice:**

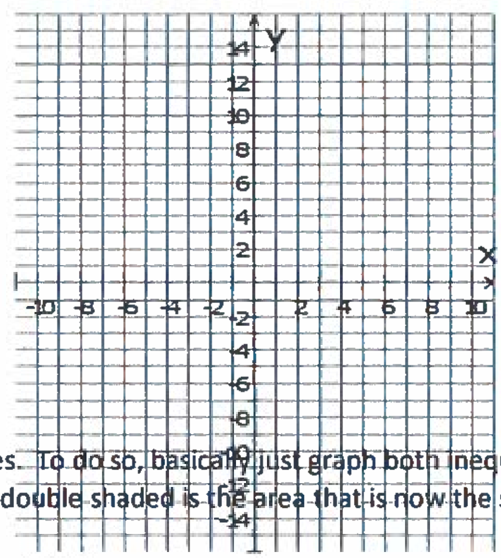
2. $y \geq x + 6$




3. $2x \geq y$




4. $x \geq 5$

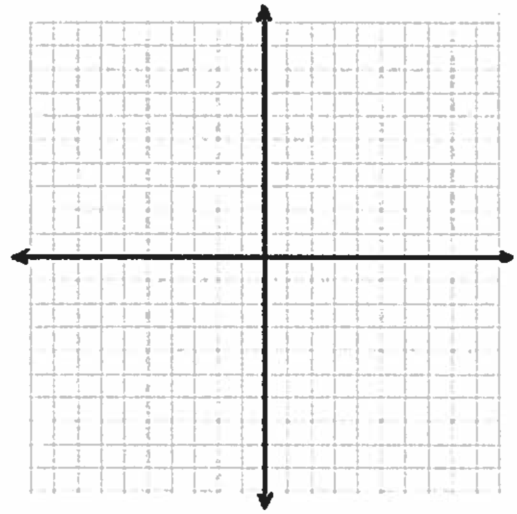



**Concept Development**

You can also graph systems of linear inequalities. To do so, basically just graph both inequalities on the same graph. When you shade, the area that is double shaded is the area that is now the solution set. We label that area with an S.

Graph the solution set to the system of inequalities.

$$2x - y < 3 \text{ and } 4x + 3y \geq 0$$



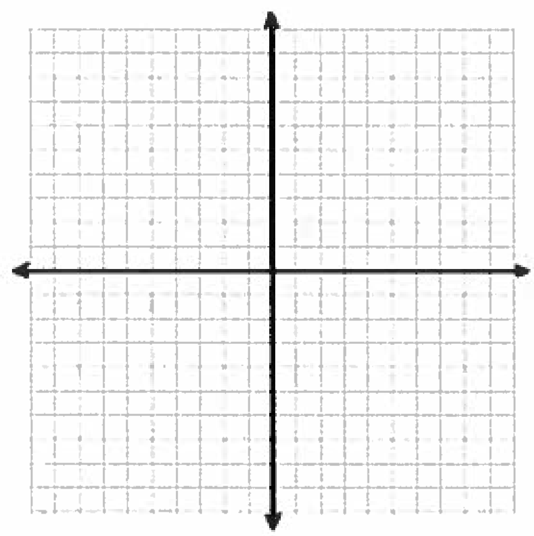
Give an example of a point that is in the solution set. ______________

Give an example of a point that is NOT in the solution set. ______________

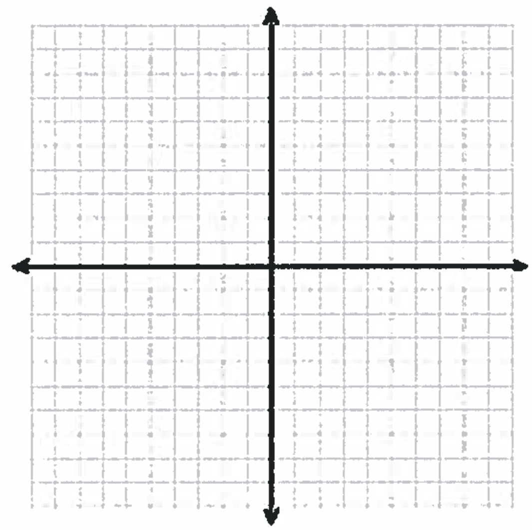
## Guided Practice:

Graph the solution set to each system of inequalities.

a. $\begin{cases} x - y > 5 \\ x > -1 \end{cases}$



b. $\begin{cases} y \leq x + 4 \\ y \leq 4 - x \\ y \geq 0 \end{cases}$



Give an example of a point that is in the solution set. ____________

Give an example of a point that is NOT in the solution set. ____________

✓ **Self Assessment:**

<u>Rate your level of understanding:</u>

1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ______________________________________________

Name: ______________________________ Date: ______________________

CW 3.5

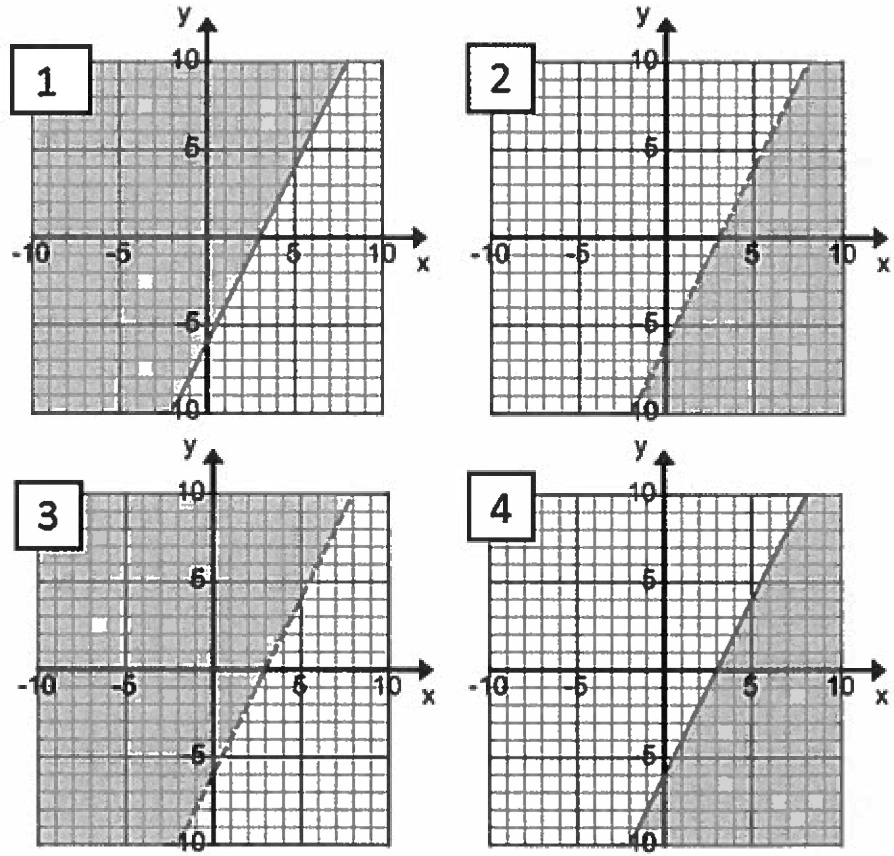
1. Match each inequality with its graph.

a. $2x - y > 6$

b. $y \leq 2x - 6$

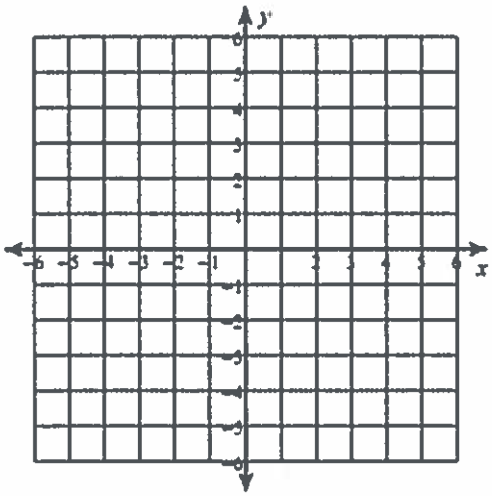
c. $2x < y + 6$

d. $2x - 6 \leq y$

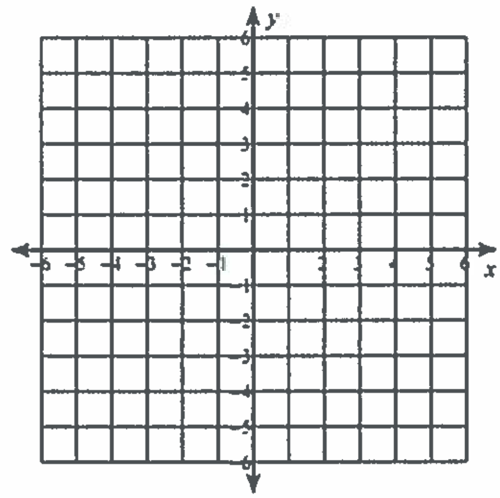


1. Graph the solution set in the coordinate plane.

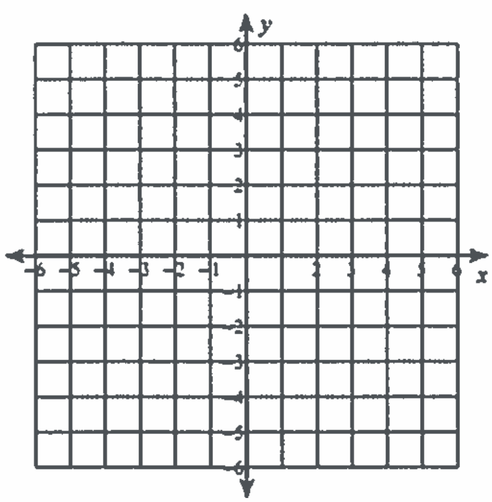
1) $y \geq -3x + 4$



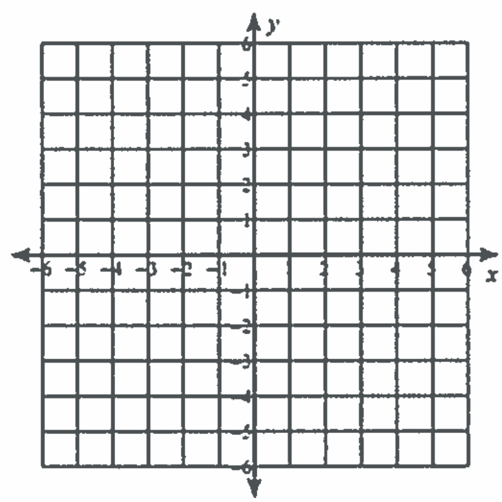
2) $y \leq \frac{3}{5}x - 5$



3) $y > -x - 5$

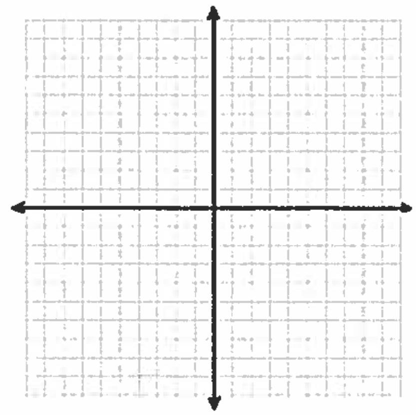


4) $y > -4$



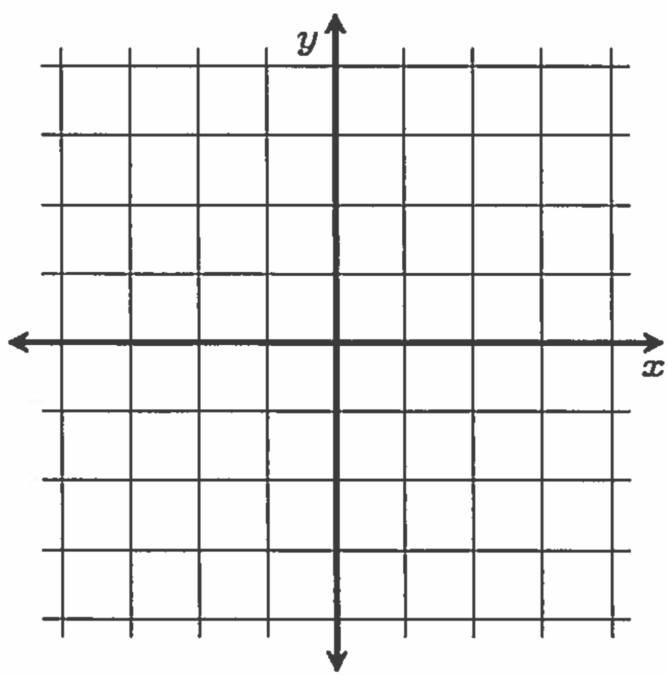
3. Graph the solution to the following system of inequalities:

$$\begin{cases} y > x - 2 \\ y \le 2x + 2 \end{cases}$$



4. Graph the solution to the following system of inequalities:

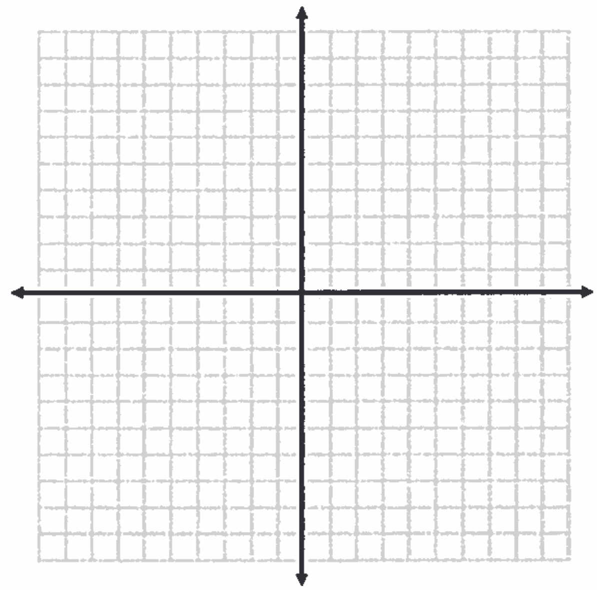
$$\begin{aligned} x &\ge -1 \\ 2x - 3y &\le 2 \\ x + y &> 1 \end{aligned}$$



Name: ______________________________ Quiz 3.5 A

Plot the solution set to the following inequality. (Graph the line…is it dotted or solid? Then test a point.)

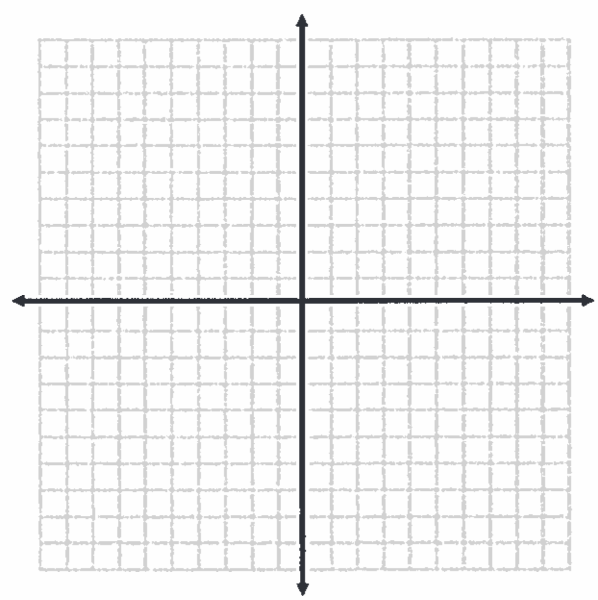
$2x + y \leq 6$



Name: ______________________________ Quiz 3.5 B

Plot the solution set to the following inequality. (Graph the line…is it dotted or solid? Then test a point.)

$2x + 3y \geq 7$



**Algebra-Unit: Solving Systems of Equations and Inequalities-Lesson 6**

Lesson Topic: Solving word problems that are represented by system of linear inequalities by graphing and review for test

Grade Level: 9

Duration: 80 minutes

Teacher Name: _______________

<table>
<tr><th colspan="3">Stage 1 – Desired Results</th></tr>
<tr><td rowspan="3">External Standards(s):<br>• A-CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context<br>• A-REI.12 Graph the solutions to a linear inequality in two variables as a half-plane</td><td colspan="2">Essential Question:<br>How can systems of inequalities be applied in real-life situations?</td></tr>
<tr><td colspan="2">Understanding Goal:<br>Students will understand that:<br>• The shaded region represents the set of solutions to a system of inequalities.</td></tr>
<tr><td>Skills: students will be able to…<br>• Solve systems of linear inequalities by graphing.<br>• Create inequalities based on a word problem.<br>• Identify constraints for a problem using the description of the word problem.</td><td>Content: (facts, vocabulary, knowledge)<br>• Equations<br>• Inequalities<br>• Constraints<br>• Variables</td></tr>
</table>

<table>
<tr><th colspan="2">Stage 2 – Assessment Evidence</th></tr>
<tr><td>Performance Task(s):<br>• Notes p.1-5</td><td>Other Evidence: (classwork, quizzes)<br>• 3.6 Classwork<br>• 3.6 Quiz</td></tr>
</table>

# Algebra

## Unit 3 – Lesson 6 – Systems of Linear Inequalities Word Problems

Name: ______________________________ Date: ________________

### Lesson Objectives:

- I can solve systems of linear inequalities by graphing
- I can create inequalities based on a word problem
- I can identify constraints for a problem using the description of the word problem.

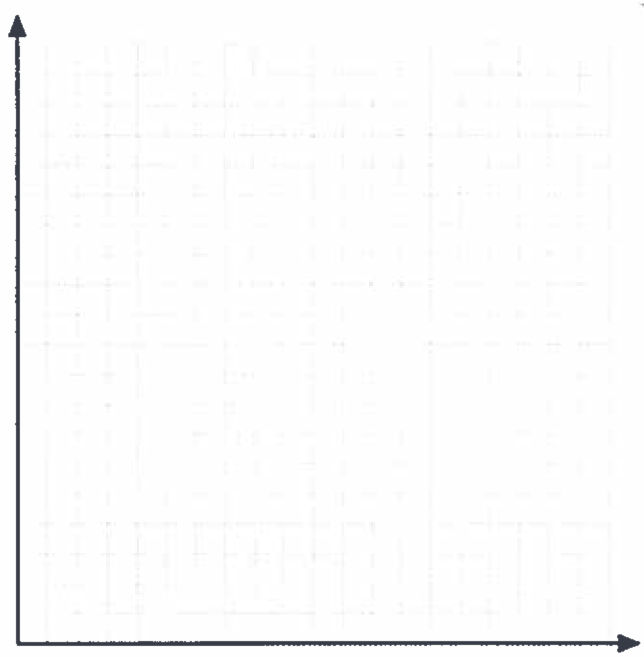
### Concept Development:

A baker has 1000 pounds of dough to make snowman cookies and star cookies. A snowman requires 1 pound of dough and a star cookie requires 2 pounds of dough. It takes 2 hours to make a snowman and 3 hours to make a star. There are 1600 hours available to make the cookies.

i. What are the variables?

ii. What are the constraints?

iii. Write inequalities for the constraints.

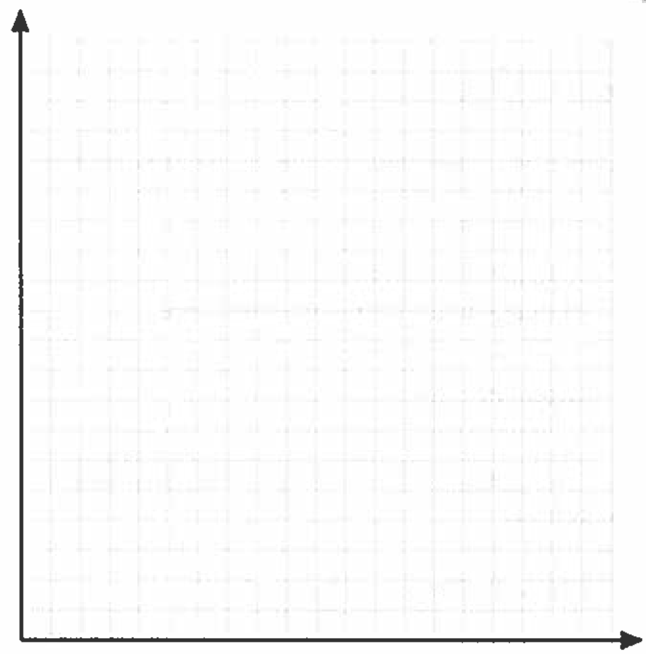


iv. Graph the inequalities and shade the solution set.

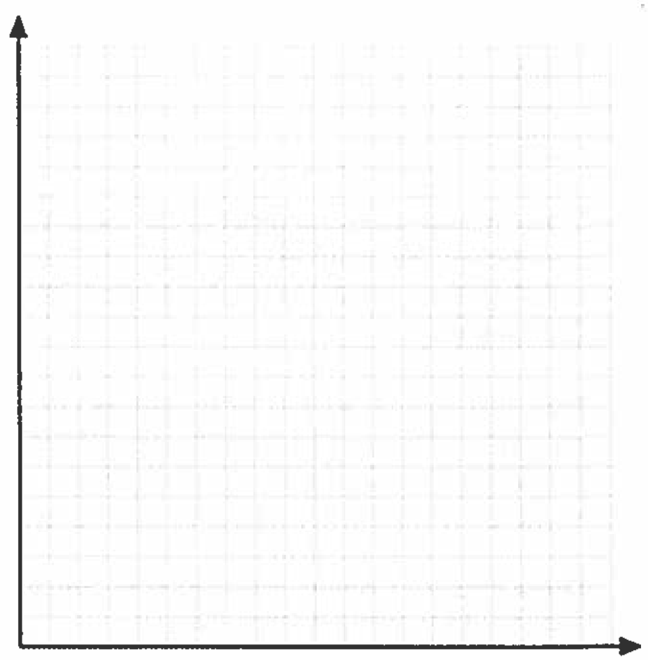
v. What does the shaded region represent?

## Guided Practice:

1. You are shopping for chips and soda at a grocery store. Each bag of chips costs \$4 and each bottle of soda costs \$2. You don't want to buy more than 20 bags of chips and bottles of soda together, and you have a \$50 budget. Find a system of inequalities representing the number of snacks you could buy.



2. Nadine is having a graduation party. She needs to buy decorations for the party and dinnerware for her guests. Her car can hold up to 10 boxes. Each box of decorations costs \$100 and each box of dinnerware costs \$150. A maximum of \$1200 is budgeted for this party. Write a system of inequalities that represents how many of each box Nadine should order.



✓ **Self Assessment:**

<u>Rate your level of understanding:</u>

1 – confused  2 – somewhat understand it  3 – completely understand it

Questions?: ______________________________________________

## Calculator Work:

You can use your calculator to help with each of the following things:

1) Graphing lines
2) Finding where lines intersect
3) Finding equations of linear functions

1) Graphing lines

**Notice that there are five buttons across the top of the calculator right below the display screen.**

**These buttons are labeled**
**[Y=]  [WINDOW]  [ZOOM]  [TRACE]  [GRAPH]**

**Before you can graph with the calculator, you must enter the equation by pressing the [Y= ], also called the [F1], button. If the calculator has been used before, the calculator will show the equation of the previous graph entered in the calculator. New or cleared calculators will show only the basic graph menu as shown below.**

```
 Plot1 Plot2 Plot3
\Y1=█
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```

**If the graphing component of the calculator has been used before, then any previous graphs will be listed in Y1=, Y2=, etc. For any of these equations that may need clearing, use the down arrow to move down to whatever lines need clearing, and press [CLEAR] for each one.**

**Now, use the arrow key (if necessary) to return to the line with Y1=, and type in the new equation to be graphed, as illustrated in the following examples. Before beginning, find the second button in the second column [X, T, θ, η], which means "*x*-variable." When you type a variable in order to draw a graph, this is the button to use!**

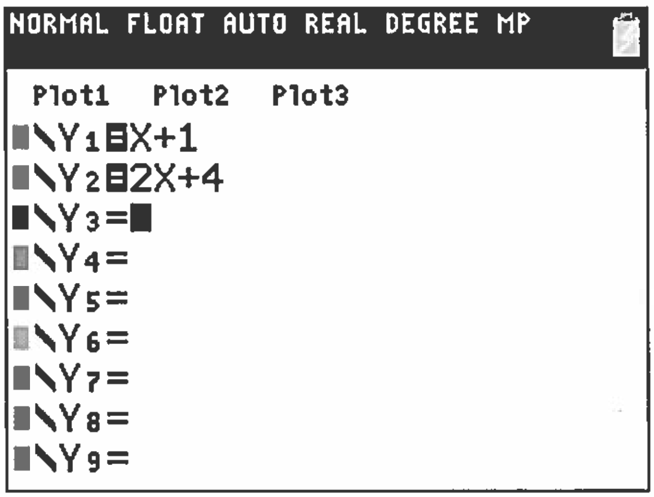
**Once you have entered the equation you wish to graph, press (F5 GRAPH). The graph of your line should show up on your screen.**

2) Finding where lines intersect

Find the intersection of the following functions:
$y = x + 1$
$y = 2x + 4$

Solution:

• Press [Y=] to display the Y= Editor.
• Press [X] [+] [1] [ENTER].
• Press [2] [X] [+] [4] [ENTER].




• Press [GRAPH] to display the graphs of the two functions
• Press [2ND] [CALC] [5].
• When *"First curve?"* is displayed, press [▲] or [▼] if necessary to move the cursor to the first function.
• Press [ENTER].
• When *"Second curve?"* is displayed, press [▲] or [▼] if necessary to move the cursor to the first function.
• Press [ENTER].

**NOTE:** The calculator requires that a first and second curve be selected in case there are more than two functions being graphed at one time. This is to specify which two functions to find the intersection of in that case.

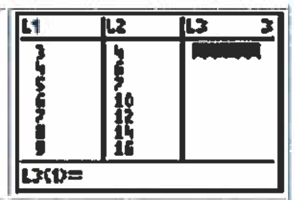
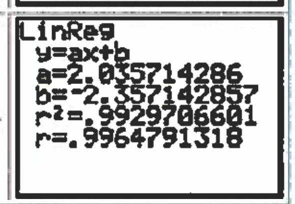
• When *"Guess?"* is displayed, use [◄] and/or [►] to move the cursor to the point that is the guess as to the location of the intersection.
• Press [ENTER].

**NOTE:** The calculator requires that a guess be made in case the functions being graphed intersect more than once. This is to specify which intersection of the two selected functions to find in that case.

3) Finding the equations of linear functions

Example: Create the lists L1=3,4,5,6,7,8,9 (which will represent the x-values) and L2=4,6,7,10,12,14,16 (which will represent the y-values). Use these points to find the line of best fit.

Before you find the line of best fit it is useful to be able to see the points plotted in what is called a scatter plot. The TI-83 will plot these points. Make sure that there are no functions in the Y= list.

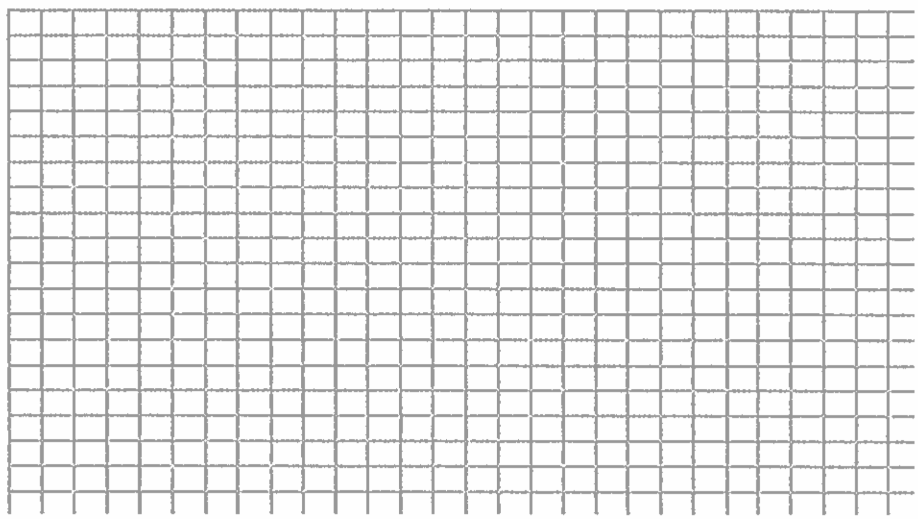
<table>
<tr><td>Create L1 and L2.</td><td>
</td></tr>
<tr><td>Go to STAT CALC 4.</td><td>
</td></tr>
<tr><td>Press ENTER and<br>you will see this screen.</td><td>
</td></tr>
<tr><td>Now press ENTER again<br>to get the equation of the line.</td><td>
</td></tr>
</table>

Name: ______________________ Date: ______________________

CW 3.6

1. Two cars are travelling north along a road. The first car travels at a constant speed of 50 mph for two hours, then speeds up and drives at a constant speed of 100 miles per hour (mph) for the next hour. The car then breaks down and the driver has to stop and wait two hours for someone to come fix it. When it is fixed, he drives recklessly at a constant speed of 100 mph. Car 2 started at the same time that Car 1 starts, but the second car starts 100 miles north of Car 1 and travels at a constant speed of 25 mph throughout the trip.

   a. Sketch the distance versus time graphs for Car 1 and Car 2 on the graph below. Start with time 0 and measure time in hours.



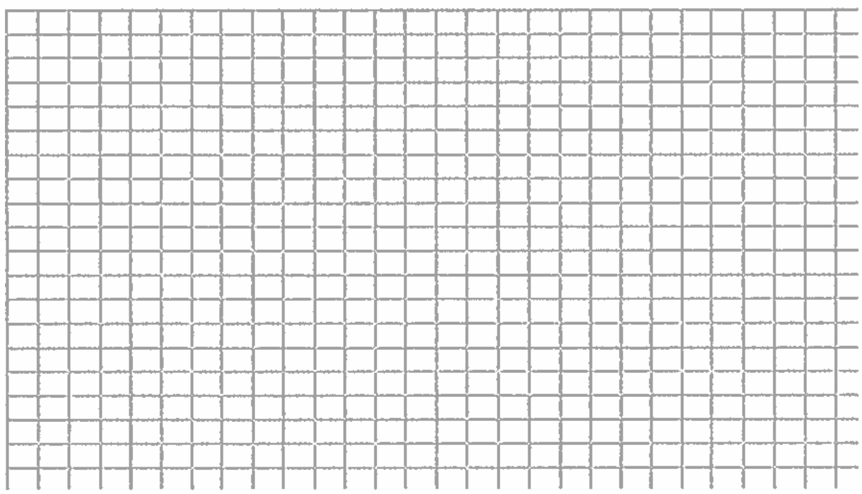
   b. Approximately when do the cars pass each other (estimate by looking at the graph)?

   c. Tell the story of the graph from the point of view of Car 2. What does the driver of Car 2 see along the way? Be sure to mention what they see and when they see it!

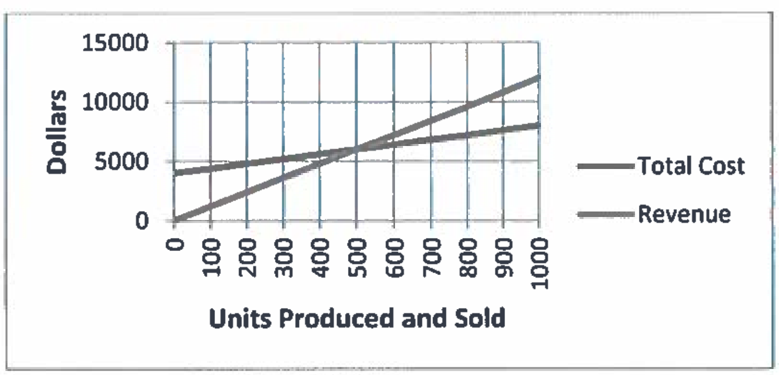
2. Suppose that in problem 1, Car 1 travels at the constant speed of 25 mph for the entire trip. Sketch the graph of distance versus time for the two cars.

   -Do the cars ever pass each other this time?

   -What is the linear equation for Car 1 in this case?



3. The following graph shows the revenue (income) a company makes from selling clothing items and the total cost (including overhead, maintenance of machines, etc.) that the company spends to make the various items of clothing.

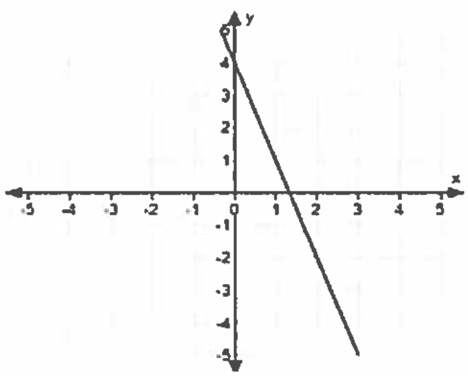



   a. What is the meaning of the point (0, 4000) on the total cost line?

   b. What are the coordinates of the intersection point? What is the meaning of this point in this situation?

c. Create linear equations for revenue and total cost in terms of units produced and sold. Verify the coordinates of the intersection point by plugging in to the equations that you created.

4. Consider two linear equations. The graph of the first equation is shown. And a table of values satisfying the second equation is given. What is the solution to the system of the two equations?



| $x$ | $-4$ | $-2$ | $0$ | $2$ | $4$ |
|---|---|---|---|---|---|
| $y$ | $-26$ | $-18$ | $-10$ | $-2$ | $6$ |

Algebra

Unit 3 Review

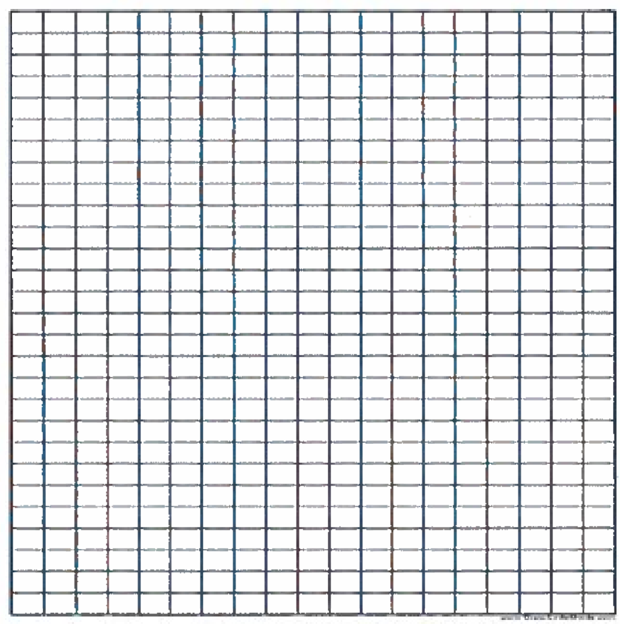
Name: ____________________________

Date: ______________________

1) Bobby is selling t-shirts and pants for his local school fundraiser. The t-shirts cost \$5 and the pants cost \$10. He wants to make at least \$200. Create an inequality that fits Bobby's situation AND graph the situation.

   a. What is one possible combination of pants and shirts that will fit Bobby's solution set?

   b. Do all values of pants and shirts fit? Describe why or why not.



2) Zach wants to buy a combination of pizza and soda. 10 items total were purchased. Soda costs \$1.50 and pizza costs \$2.00, and he has a total of \$18.00 to spend. How many of each item does he end up purchasing?

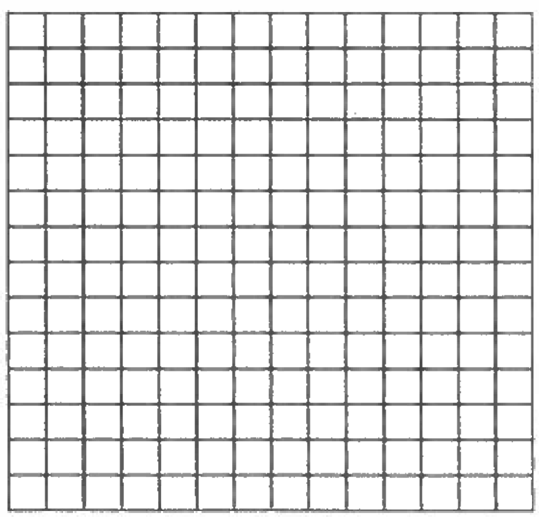
3) Functions:

   a. Draw an example of a quadratic function, and describe where you may see it in real life.

   b. Draw an example of an exponential function.

4) Joe and Kathy live at opposite ends of the hall. Joe's door is 80 feet from Kathy's. They walk towards each other, Joe moving at 5 feet per second and Kathy moving at 4 feet per second.

   a. Graph both Joe and Kathy's distances, in feet, from Joe's door vs. time in seconds.



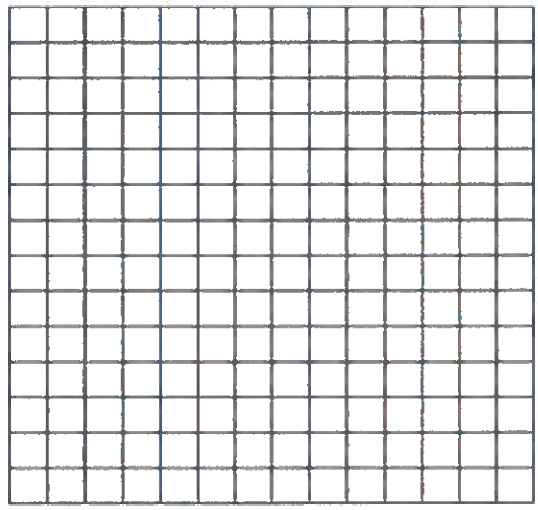
   b. At approximately what time will they meet?

   c. Find the equations for both Joe and Kathy.

   d. Using algebra, verify that your answer to part (b) is correct by finding the EXACT time when Joe and Kathy meet.

5) Tom and Sally are going to the mall. At 10 AM, Tom leaves his car and drives at a rate of 40 miles per hour. After 15 minutes, he gets stuck in traffic for another 15 minutes. Then, he continues on his journey for 45 minutes at a rate of 50 miles per hour. When they arrive, they drive at a rate of 5 miles per hour in the parking lot for another 15 minutes looking for a place to park.

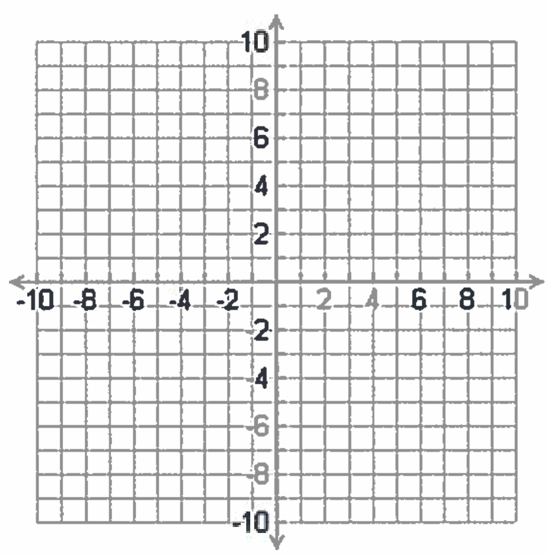
a. Draw a graph that shows the distance vs. time for Tom's trip to the mall. Remember to label your axes with the units you chose and any important points (home, mall, etc.)



b. What was the total distance that Tom drove to the mall? How much time did it take him?

6) Graph the lines below, and find their intersection point graphically.

$$2x + y = 9$$
$$3x - y = 16$$



7) Solve the following system algebraically (use either substitution or elimination).

$$\begin{cases} 3x + y = 9 \\ 5x + 4y = 22 \end{cases}$$

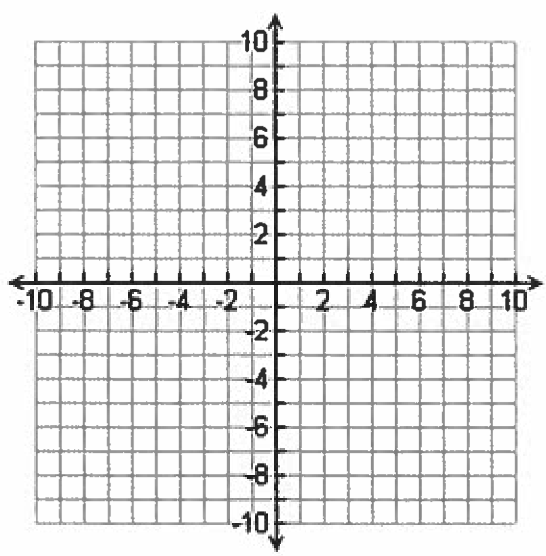
8) Solve the following system algebraically (use either substitution or elimination).

$$\begin{cases} 2y - 4x = 2 \\ y = -x + 4 \end{cases}$$

9) Graph the following system of linear inequalities. **Name one point in the solution set, and one point not in the solution set.**

$x + 2y \leq 8$

$y \leq x + 4$



Algebra | Name: ____________________________

Unit 3 Exam | Date: ____________________

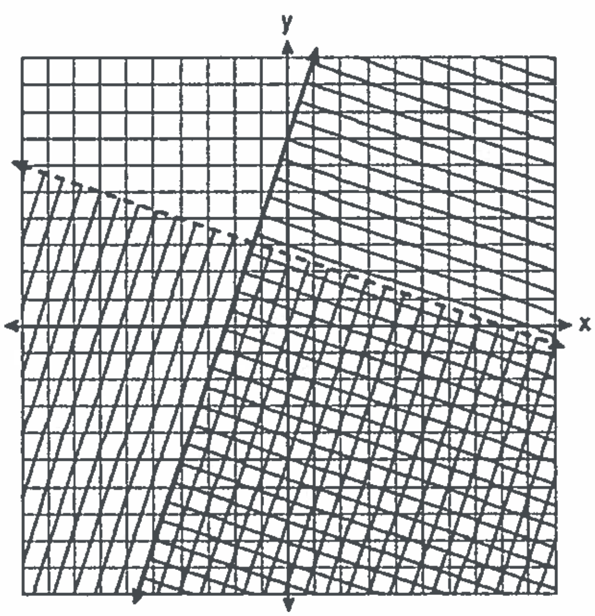
Score: ______ / 75

**Part One - Multiple Choice Questions (24 points total). Answer all questions in this part. Each correct response, with appropriate work will receive 3 points. You may receive 3 points for correct work and the correct answer, 2 points for the correct answer with no work, 1 point for the incorrect answer but appropriate work, and 0 points for the incorrect answer and no appropriate work.**

1. Which of the following situations models a quadratic function?

   1) The growth of a population of the local deer population
   2) The growth of bacteria in a Petri dish
   3) The path of a bouncing ball
   4) Rate versus time

2. Which ordered pair is in the solution set of the system of linear inequalities graphed below?




   1) $(1,-4)$
   2) $(-5,7)$
   3) $(5,3)$
   4) $(-7,-2)$

3. Simplify the following expression: $(5x^2 - 3x + 5) - 2(x^2 - 8x - 1)$

1) $3x^2 + 13x + 7$

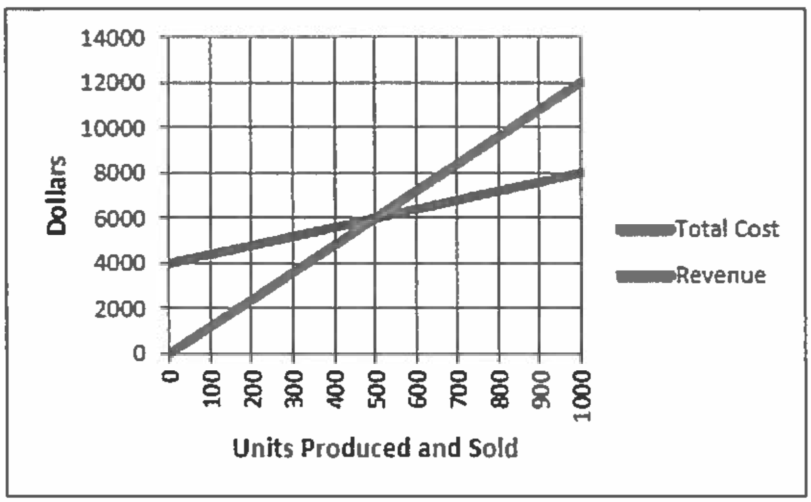
2) $3x^4 + 13x^2 + 7$

3) $7x^2 - 5x + 3$

4) $3x^2 - 11x + 3$

4. Use the graph below:

The following graph shows the revenue (or income) a company makes from designer coffee mugs and the total cost (including overhead, maintenance of machines, etc.) that the company spends to make the coffee mug.




How many units must be produced and sold for the company to make a profit (revenue is higher than total cost)?

1) ( 0, 500 )

2) [ 0, 500 ]

3) [ 500, ∞ )

4) (500, ∞ )

5. Which of the following situations does **not** model a quadratic function?

1) Shooting a basketball
3) A frog jumping from lily pad to lily pad
2) The growth bacteria doubling
4) A girl jumping rope

6. Assume that a bacteria population doubles every hour. Which of the following tables of date, with $x$ representing time in hours and $y$ the count of bacteria, could represent the bacteria population with respect to time?

a)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $x$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| $y$ | 1 | 3 | 7 | 13 | 21 | 31 | 43 |

b)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $x$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| $y$ | 4 | 6 | 10 | 13 | 16 | 19 | 22 |

c)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $x$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| $y$ | 3 | 6 | 12 | 24 | 48 | 96 | 192 |

d)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $x$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| $y$ | 2 | 6 | 10 | 14 | 18 | 22 | 26 |

7. Find the values that make the denominator equal to zero: $\frac{x-6}{2x(x+5)}$

1) { -5, 2, 0, 6 }
3) { -5, 0 }
2) { }
4) { -5, 0, 6 }

8. Solve and graph the following inequality: $-4 < 6 - 2x \leq 8$

a) In words:

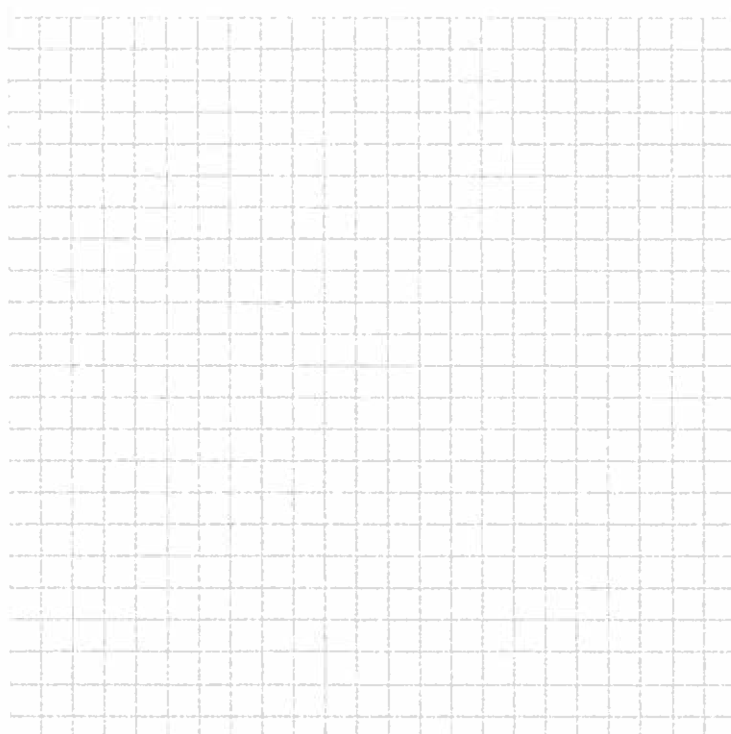
b) Set notation:

c) Interval notation:

d) Number line:

**Answer all questions in this part. Each correct answer will receive the credits listed. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit.**

9. **(4 points)** Sue needs golf balls and tees before the spring golf season begins. She only has \$42 to spend, so she can't spend more than \$42. If a box golf balls cost \$18 and a bag of tees cost \$2, create the linear inequality that fits Sue's situation and find a possible number of box(es) of golf balls and number of bag(s) of tees that Sue could purchase? **(Graph and inequality are worth 3 points, possible solution to inequality worth 1 points.)**



10. **Students and adults purchased tickets for a recent basketball playoff game. All tickets were sold at the ticket booth—season passes, discounts, etc. were not allowed.**

    **Student tickets cost \$5 each, and adult tickets cost \$10 each.**
    **A total of \$4500 was collected. 700 tickets were sold.**

a) **(4 points)** Write a system of equations that can be used to find the number of student tickets, ***s***, and the number of adult tickets, ***a***, that were sold at the playoff game. **Solve** this system using whatever method you prefer.

b) **(2 points)** Using your answer from part a, use the number of adult tickets sold and the number of student tickets sold to determine how much more money could have been collected at the playoff game if the student price was kept at \$5 per ticket and the adults were charged \$15 per ticket instead of \$10?

11. Alexus is modeling the growth of bacteria for an experiment in science. She assumes that there are $B$ bacteria in a Petri dish at 12:00 noon. In reality, each bacterium in the Petri dish subdivides into two new bacteria every 20 minutes.

a. Create a table that shows the total number of bacteria in the Petri dish at 1/3 hour intervals for 2
Create a table that shows the total number of bacteria in the Petri dish at 20 minute intervals for 2 hours, starting with time 0 to represent 12:00 noon. The table has been started for you. **(3 points)**

| Time | 0 (12:00) | 1 (12:20) | 2 (12:40) | | | | |
|---|---|---|---|---|---|---|---|
| Number of Bacteria | B | 2B | 4B | | | | |

b. The equation that describes the relationship between total number of bacteria $T$ and time $h$ in hours, assuming that there are $B$ bacteria in the Petri dish at $h = 0$ is, **$T = B(2)^{(3h)}$**

If Alexus starts with 100 bacteria in the Petri dish, draw a graph that displays the total number of bacteria with respect to time from 12:00 noon ($h = 0$) to 4:00 p.m. ($h = 4$). Label points on your graph at time $h = 0, 1, 2, 3, 4$. Since she is starting with 100 bacteria, B will be replaced with 100.

| Hours = h | Number of Bacteria = $100(2^{3h})$ |
|---|---|
| 0 | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |

Fill out the table, and graph the values you find.
**(6 points – 3 for table, 3 for graph)**

12. Jacob and his friends are going to Six Flags. At 8:00am, Jacob hops in his car and drives at a constant speed of 30 miles per hour for half an hour to pick up Ricardo. Ricardo isn't ready so Jacob has to wait 15 minutes. The boys drive at a constant rate of 60 mph for 2 hours. When they arrived, there was a traffic jam and the boys traveled at a constant speed of 2 mph for 1 hour.

    a. Draw a graph that shows the distance Jacob drove to Six Flags with respect to time. Remember to label your axes with the units you chose and any important points (home, Ricardo's house, etc.) **(4 points)**

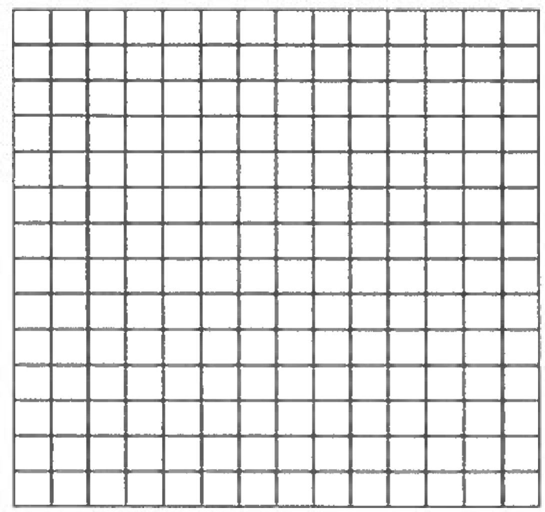
    b. What was the total distance Jacob drove to Six Flags? **(2 points)**

13. Solve the following system using the process of elimination: **(3 points)**

$$4x - 3y = 25$$
$$-3x + 8y = 10$$

14. Melissa and Walter live at opposite ends of the same street. Their front doors are 50 feet apart. They each start at their door and Melissa walks at a constant rate of 3 ft/sec and Walter jogs at a steady rate of 5 ft/sec and move towards each other.

   a. Accurately graph both Melissa's and Walter's distances in feet from Melissa's door versus time in seconds. **(4 points)**



   b. According to your graphs, ***approximately*** what time will Melissa and Walter meet? **(2 points)**

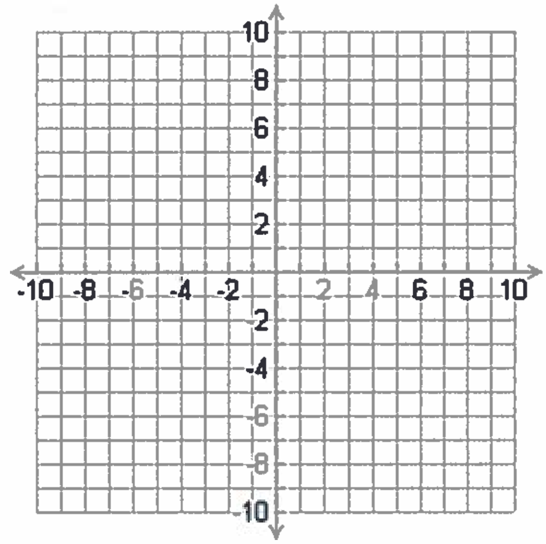
   c. Determine the equations that represent Melissa and Walter's paths. **(3 points)**

   d. Using the equations that you found in part c, determine the ***exact*** time when Walter and Melissa meet. **(2 points)**

15. Graph the following system of linear inequalities. Be sure to label the solution set with an S. **(4 points)**

$y < -3x + 4$

$2x - y \geq 5$



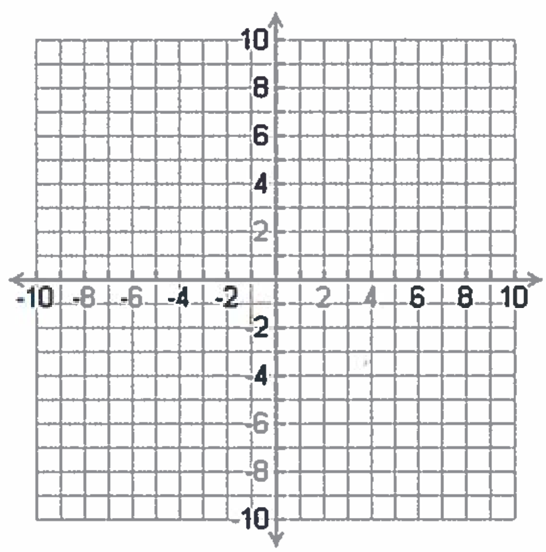

a. Name one point in the solution set **(1 point):**

b. Name one point NOT in the solution set **(1 point):**

16. a. Graph the system below, and find the intersection point. **(3 points)**

$y = -3x + 6$

$x + 3y = 18$




b. Using substitution, confirm that the system has the solution that you found above. **(3 points)**

# CHAPTER 4: VALIDITY

This unit plan was reviewed by a veteran mathematics teacher who has experience teaching Algebra I. His knowledge of the content and working with disengaged students validates the curriculum's situated lessons. The feedback will be used to modify the lessons so that they can be better implemented to teach solving systems of equations and inequalities. The feedback is paraphrased as follows:

Strengths

- A lot of real life application
- Compare and contrast different functions
- Love the YouTube video about exponential functions
- The reflective questions allow you to "differentiate" material
- I think it is a good idea to start with solving systems graphically first and then introduce other methods

Suggestions and Questions

- I really like the TI-Nspire graphing calculators, provided they are available
- I like the quizzes and exam, but consider assigning some inquiry based instruction. Students learn more from project based learning with real life applications.
- I would also emphasize graphing without the use of a calculator. When students know how to manipulate slope intercept and point slope formulas, they better synthesize the material and makes the graphing calculator become a better tool.
- Need to find ways to emphasize literacy strategies, especially in math.

Overall, the teacher stated that the lessons aligned well to the content, and the contexts used were appropriate and meaningful for teaching disengaged students. The primary content goals of this curriculum were to review solving systems of equations and to progress to solving and graphing inequalities and systems of inequalities. These goals were both met by having the students problem solve within various contexts. The real life situations presented in the lessons allow for students to relate the similarities and differences of solving systems of solving systems of linear equations and solving systems of inequalities. The teacher agreed that the contexts used would help students see the relationship between equations and inequalities, and that using that relationship would help students to better understand the process to solving inequalities.

In the teacher's feedback, he included some suggestions to improve the lessons. One suggestion that he made was to include more inquiry based instruction. In a general education classroom, this suggestion would be able to be implemented successfully. Since this curriculum was designed for an alternative education setting with a hybrid classroom, the chance that inquiry-based learning would be successful is slim due to the large amount of absences.

Another suggestion that was made was to put less emphasis on the use of a calculator. Over the years, students have become more and more calculator-dependent and are able to do less and less work without the use of a calculator. Many of the students in alternative education centers are course-repeaters who failed the same course the previous year. As a result, they are discouraged from attempting to learn material and are interested solely in passing the course and moving on. Algebra I is a New York State requirement for a Regents Diploma, and if students struggle to learn the content or pass the Algebra I Regents Exam, they often rely on calculator shortcuts instead of understanding the mathematical content and connections.

# CHAPTER 5: CONCLUSION

This curriculum project was designed to support educators teach solving systems of equations and inequalities to alternative education students in Algebra I. Educators are encouraged to differentiate these documents and lesson plans to help meet the needs of their individual students. Provided that technology is available, the author suggests that these materials be presented to students using a hybrid-classroom approach in order to allow students access inside and outside of the classroom to fully develop the connection between solving systems of equations and solving systems of inequalities.

Although teaching mathematics in a nontraditional setting is more challenging, this obstacle can be overcome by using nontraditional teaching methods. This curriculum combined with a hybrid classroom setting allows students easy access to the classroom via multiple outlets. In addition, this curriculum allows students to make connections between solving systems of equations and solving systems of inequalities. The tasks build off student knowledge of linear functions and systems of equations so that they have a knowledge base to start with when learning about systems of inequalities. In addition, the application contexts used within the lessons deal with a fair amount of monetary situations. Students can easily relate to these as they are consumers and will someday become employees. Within each lesson, students rearrange equations and inequalities to be in slope-intercept form, and use different methods of solving to obtain solutions. The presentation of different methods of solving allows the students flexibility in the way in which they present their work. This is especially important for alternative education students because of the fact that they are already struggling to engage. When presented with options, students are able to choose the method by which they complete a problem, and in turn will feel more successful.

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**Appendix A**

**Algebra**

**Unit 3 – Lesson 1 – Graphing Lines By Plotting Points**

Name: Key  Date:__________

## Lesson Objectives:

- I can recognize and identify solutions to two-variable equations.
- I can represent the solution set graphically.
- I can create two variable equations to represent a situation.
- I understand that the graph of the line $ax + by = c$ is a visual representation of the solution set to the equation $ax + by = c$.

## Accessing Prior Knowledge:

a. Circle all the ordered pairs $(x, y)$ that are solutions to the equation $-\frac{1}{2}x = y - 8$.

$(0,8)$ $(2,3)$ $(-2,9)$ $(0,0)$ $(1,-6)$

$(-4,10)$ $(0,-10)$ $(3,4)$ $(2,7)$ $(-4,-1)$

b. How did you decide whether or not an ordered pair was a solution to the equation?

plug in & check

c. Now, find 5 more solutions where one or more variables are **negative numbers or non-integer values.**

→ Answers may vary

$(-11, \frac{27}{2})$ $(-16, 16)$ $(-5, \frac{21}{2})$

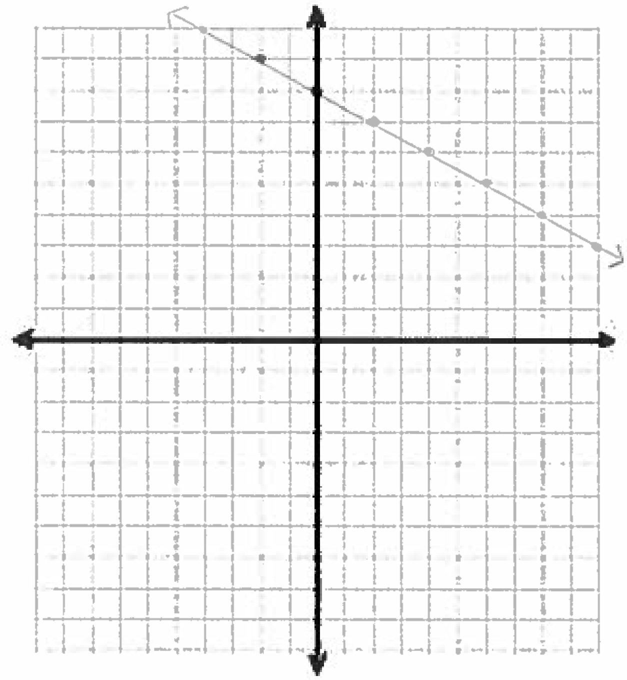
$(-14, 15)$ $(-8, 12)$

## Concept Development:

### Exercise 1

a) How many ordered pairs $(x, y)$ will be in the solution set of the equation $-\frac{1}{2}x = y - 8$?

Infinitely many



b) Create a visual representation of the solution set by plotting each solution as a point $(x, y)$ in the coordinate plane.

✓

c) Why does it make sense to represent the solution to the equation $-\frac{1}{2}x = y - 8$ as a line in the coordinate plane?

Drawing the line is the only way to include all possible solutions

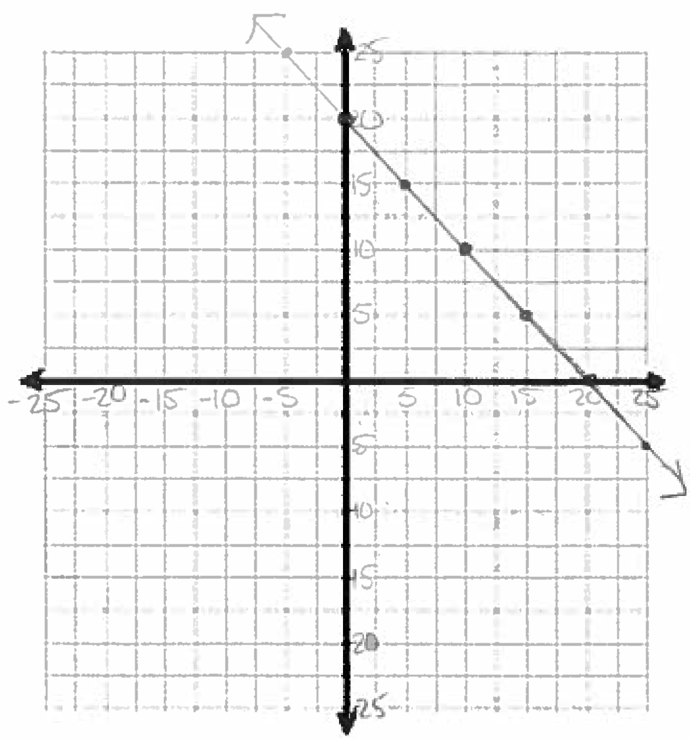
### Exercise 2

The sum of two numbers is 20. What are the numbers?

a) Create an equation using two variables to represent this situation. What is the meaning of each variable?

x = one #
y = another #

$x + y = 20$




b) List at least 6 solutions to the equation you created in part (a).

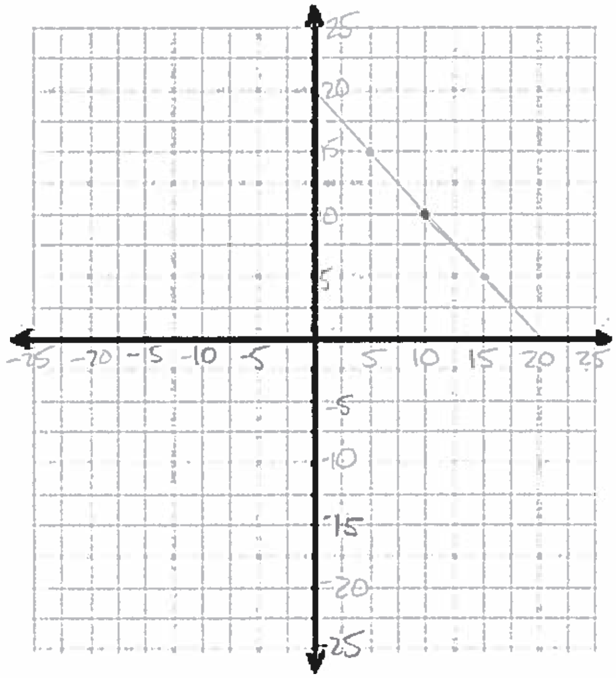
(0, 20) (10, 10)
(5, 15) (15, 5)
(20, 0) (25, -5)

c) Create a graph that represents the solution set to the equation.

✓

## Guided Practice:

### Exercise 3




Kelsee had a container with 20 markers of her favorite colors, blue and purple. How many markers of each color did she have in the container?

a) Create an equation using two variables to represent this situation. What is the meaning of each variable?

x = # of blue markers
y = # of purple markers

$x + y = 20$

b) List at least 3 solutions to the equation you created in part (a).

(10, 10) (15, 5)
(5, 15)

c) Create a graph that represents the solution set to the equation.

✓

d) Compare your solutions to exercises 2 and 3. How are they alike? How are they different?

In #4, we can't have negative numbers. In #3, there are an infinite # of answers and in #4, there are a finite # of answers.

| |
|---|
| An ordered pair is a __solution__ to a two variable equation. When the ordered pair is plugged into the equation, it will make the number sentence __true__. |

# Algebra
## Unit 3 – Lesson 2 – Introduction to Graphing Functions

Name: Key Date: ____________

**Lesson Objectives:**

- I can sketch the basic functions necessary for success in algebra this year.
- I can distinguish between piecewise, linear, quadratic, and exponential functions.
- I recognize that real life examples can be represented by of each type of function.

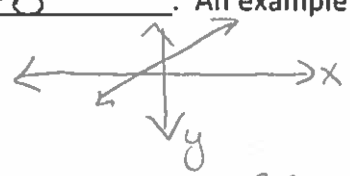
**Concept Development:**

There are four main types of functions that we will be discussing this year:

1) linear
2) piecewise
3) quadratic
4) exponential

**Linear Functions**

Linear functions are functions that produce lines. A line is generally in the form $y = mx + b$. An example of a line is drawn below.

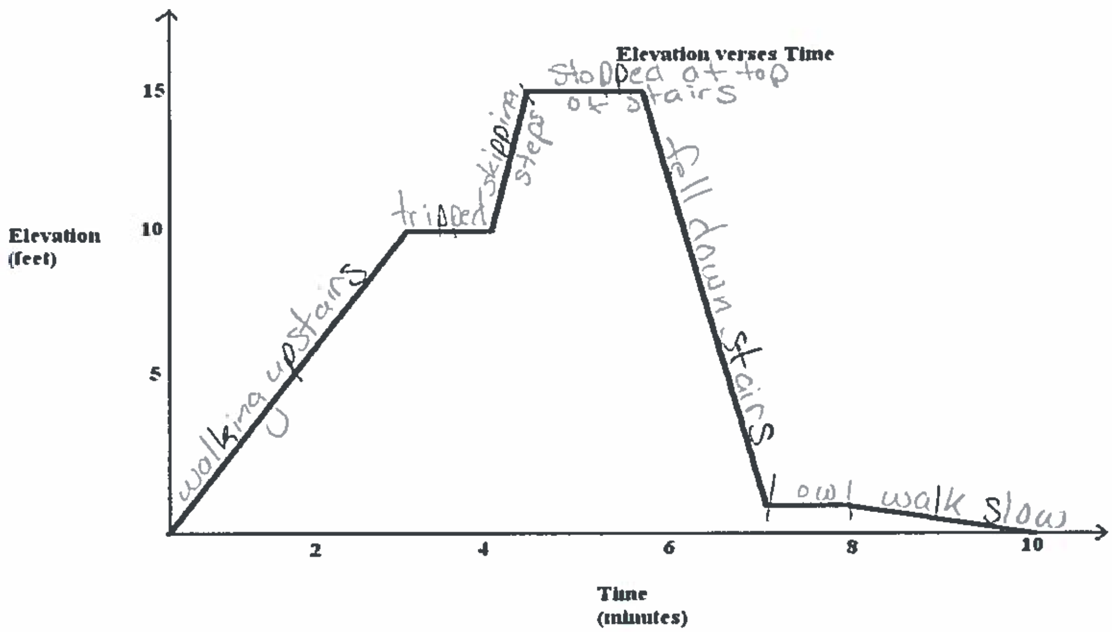



In a linear function, the rate of change is constant.

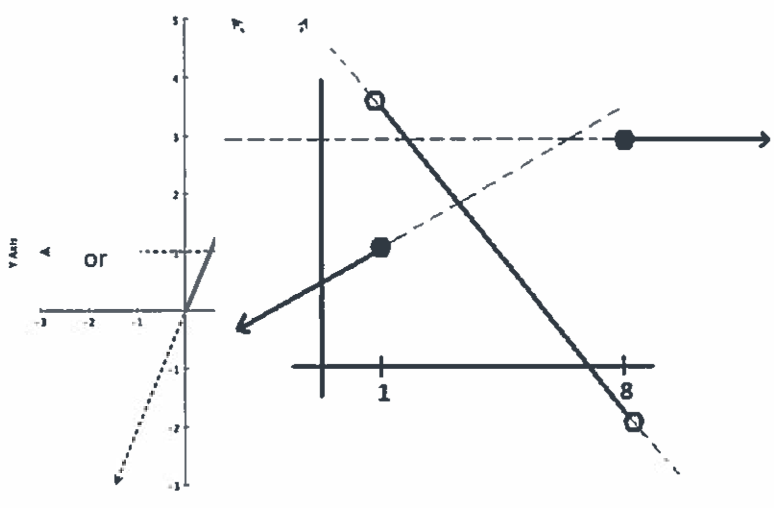
Real life examples of linear functions: Age: 1 yr./365 days
Driving: mph

## Piecewise Functions

Here is an elevation-versus-time graph of a person's motion. Can we describe what the person might have been doing?




**PIECEWISE-DEFINED LINEAR FUNCTION**: Given non-overlapping intervals on the real number line, a *(real) piecewise linear function* is a function from the union of the intervals on the real number line that is defined by linear functions on each interval.




*more than one function

✓ **Self Assessment:**

Rate your level of understanding:

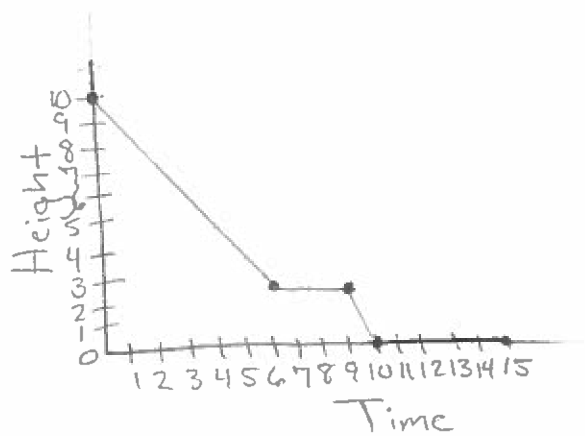
1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ______________________________

**Guided Practice: (Real life example)**

1. A man is climbing down a ladder that is 10 feet high. At time 0 seconds, he is 10 feet above the ground. At 6 seconds, he is at 3 feet above the ground. Between the 6 second and 8.5 second marks, he stops to drink some water on the step that is 3 feet off the ground. After drinking the water, he takes 1.5 seconds to descend the rest of the ladder to the ground. He then walks into the kitchen.

   a) Draw your own graph for this graphing story. Use straight line segments in your graph to model the elevation of the man over different time intervals. Label your $x$-axis and $y$-axis appropriately and give a title for your graph.




   b) Your picture is an example of a graph of a piecewise linear function! Each linear function is defined over an interval of time. These intervals of time are represented on the horizontal axis (seconds). List those time intervals.

① [0,6) ② [6,8.5) ③ [8.5,10) ④ [10,15]

   c) In your graph in part (a), what does a **horizontal** line segment represent in the graphing story?

(flat)

elevation is not changing

d) Suppose the ladder is descending into the basement of the apartment. The top of the ladder is at ground level (0 feet) and the base at the ladder is 10 feet below ground level. How would your graph change in observing the man following the same motion descending the ladder?

entire graph would shift down 10

e) What is his average rate of descent between time 0 seconds and time 6 seconds? What was his average rate of descent between time 8.5 seconds and time 10 seconds? Over which interval does he descend faster? Describe how your graph in part a can also be used to find the interval during which he is descending the fastest.

① −7/6 ② 0/2.5 ③ −3/1.5 ④ 0/5

③

slope the steepest

**Quadratic Functions**

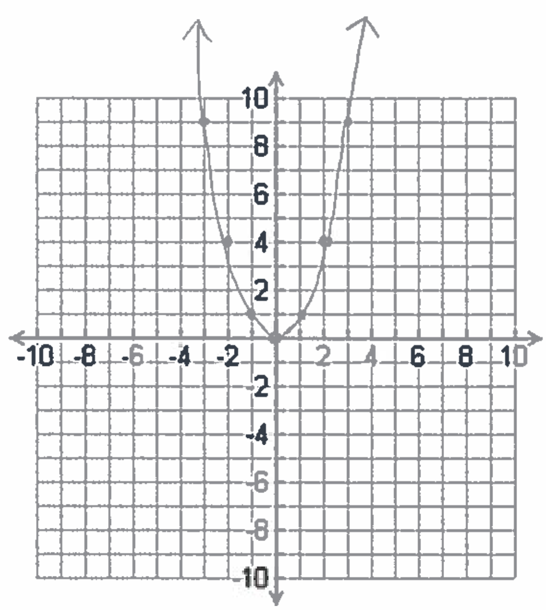
Quadratic functions are functions that produce parabolas. A parabola is generally in the form $y = ax^2 + bx + c$. An example of a line is drawn below.

The table below gives the area of a square with sides of whole number lengths. Have students plot the points in the table on a graph and draw the curve that goes through the points.

*plot these points

| *Side* (cm) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| *Area* ($cm^2$) | 0 | 1 | 4 | 9 | 16 |

On the same graph, reflect the curve across the $y$-axis. This graph is an example of a "graph of a quadratic function."



In a quadratic function, the rate of change is not constant.

Real life examples of quadratic functions:

- sound
- jumping
- smile

✓ **Self Assessment:**

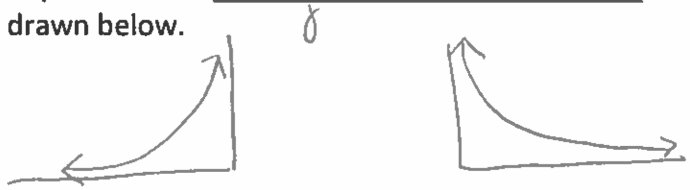
Rate your level of understanding:

1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ____________________

**Exponential Functions**

Exponential functions are functions that produce growth or decay. An exponential graph is generally in the form $y = a \cdot b^x$. A real life example of an exponential graph is drawn below.



http://www.youtube.com/watch?v=KxB43PxasGA

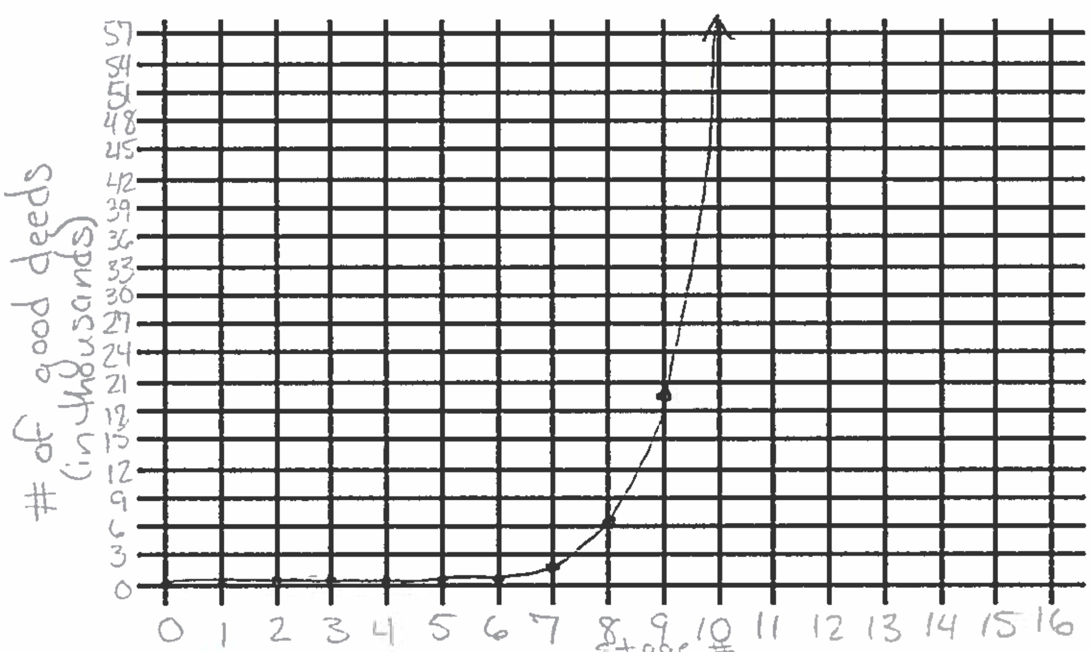
1. What is your best guess about the number of people who would receive Pay It Forward good deeds at the tenth stage?

*make your guess*

2. How many people would receive a Pay It Forward good deed at each of the next several stages?
   a. Make a table that shows the number of people who will receive good deeds at each of the next seven stages of the Pay It Forward process.

| Stage of Process | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of Good Deeds | 3 | 9 | 27 | 81 | 243 | 729 | 2187 | 6461 | 19683 | 59049 |
| | $3^1$ | $3^2$ | $3^3$ | $3^4$ | $3^5$ | $3^6$ | $3^7$ | $3^8$ | $3^9$ | $3^{10}$ |

   b. Now plot the data on a graph. Make sure you have accurate axes labels and scales.




3. How does the number of good deeds at each stage grow as the tree progresses? How is that pattern change shown in the plot of the data?

x3 pattern

4. Write a rule relating Number of Good Deeds (N) to the Stage of Process (x). This rule could be used to model the Pay It Forward Process in which each person does good deeds for three other new people.

$N = \underline{1} \cdot \underline{3}^x$

| X | N |
|---|---|
| 0 | 1 |
| 1 | 3 |
| 2 | 9 |
| 3 | 27 |

**Lesson Summary:**

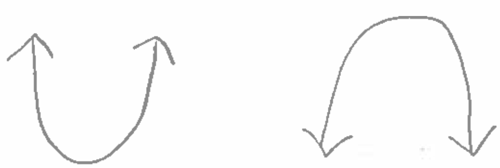
Linear functions look like:


Linear functions are called lines, and are in the form $y=mx+b$.

Piecewise linear functions look like:

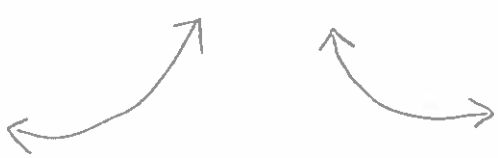
Piecewise linear functions are called piecewise, and are in the form $y=\{$.

Quadratic functions look like:



Quadratic functions are called parabolas, and are in the form $y=ax^2+bx+c$.

Exponential functions look like:



Exponential functions are called exponential, and are in the form $y=a\cdot b^x$.

**Algebra**

**Unit 3 – Lesson 3 – Solving Linear Systems by Graphing**

Name: Key Date: ____________

**Lesson Objectives:**

- I can graph multiple linear equations on the same graph
- I can identify a solution to a graph as an intersection point of the two graphs
- I can solve real life problems by graphing linear systems

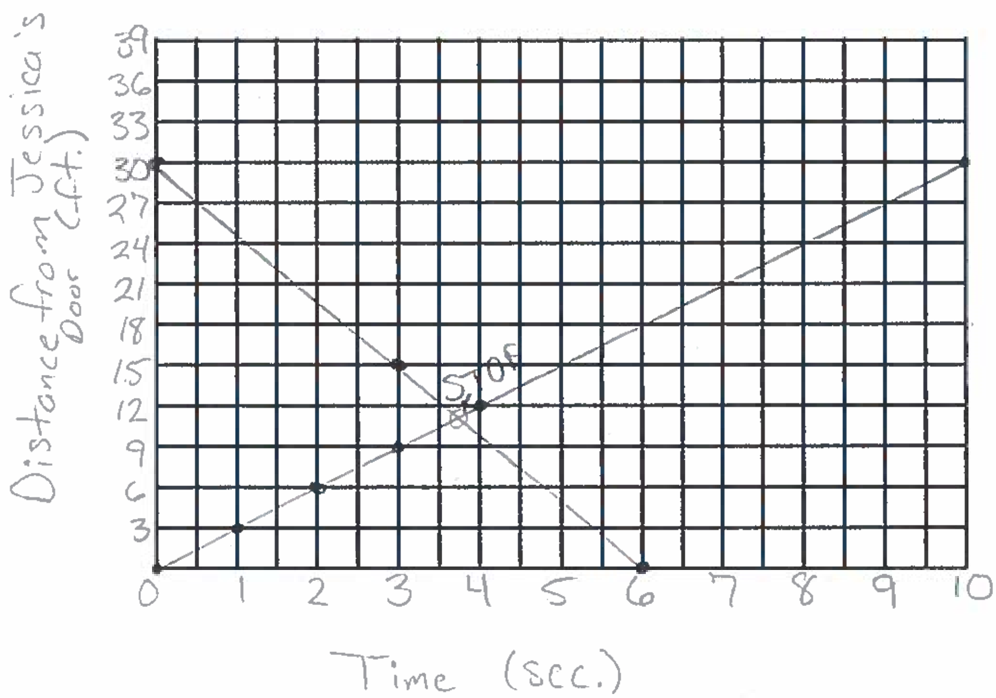
**Concept Development:**

**Example 1:**

*John and Jessica are brother and sister. Their bedrooms are at the opposite ends of the upstairs hallway, 30 feet apart. Each starting at their own door, they walk at a steady pace towards each other and stop when they meet.*

Jessica walks at a pace of 3 feet per second and John walks at a pace of 5 feet per second. What would their graphing stories look like if we put them on the same graph? What would happen on the graph when John and Jessica meet in the hallway? Sketch a graph that shows their distance from Jessica's door.

→ intersection



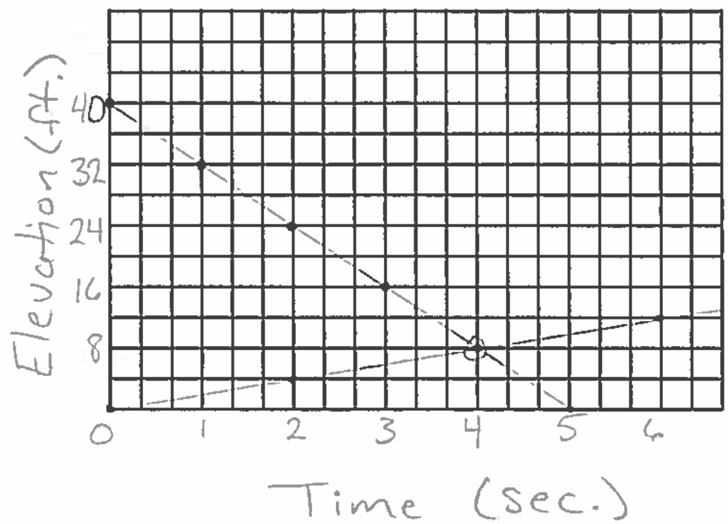

Jessica 3 ft/sec

John 5 ft/sec

**Example 2:**

*Tim starts at the bottom of a staircase and walks up it at a constant rate. His elevation increases by two feet every second. Just as Tim starts walking up the stairs, Keisha starts at the top of the same 40 foot staircase and begins running down the stairs at a constant rate of eight feet per second.*

a. Sketch two graphs on the same set of elevation-versus-time axes to represent Tim's and Keisha's motions.




b. What are the coordinates of the point of intersection of the two graphs? At what time do Tim and Kiesha pass each other?

4 seconds

c. Write down the equation of the line that represents Tim's motion as he moves up the stairs and the equation of the line that represents Kiesha's motion as she moves down the stairs. Verify that the coordinates that you found in part (b) work for the equations that you wrote for part (c).

Tim: ↑ 2ft/sec     starts @ 0

Kiesha: ↓ 8ft/sec     starts @ 40

slope     y-intercept

slope

$y = mx + b$

y-intercept (y-coordinate)

Tim: $y = 2x + 0$ or $y = 2x$

Kiesha: $y = -8x + 40$

✓ **Self Assessment:**

<u>Rate your level of understanding:</u>

1 – confused    2 – somewhat understand it    3 – completely understand it

Questions?: ______________________________

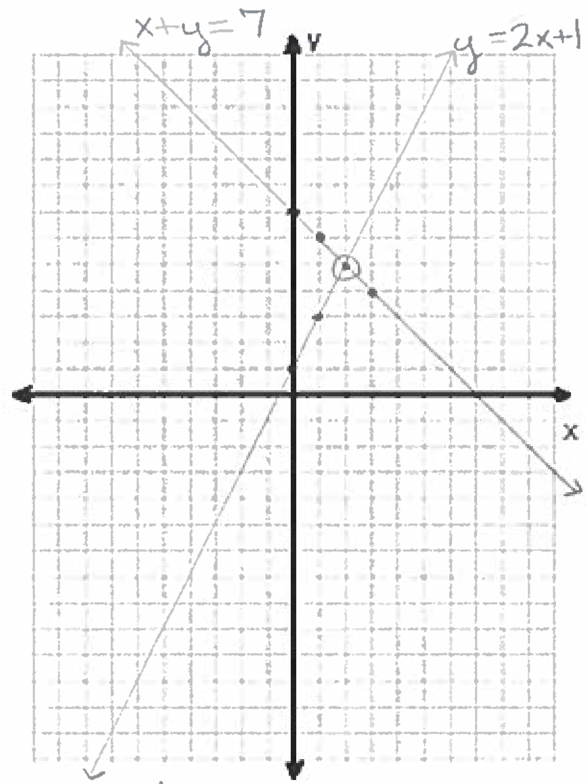
**Example 3:**

Solve the following system of equations graphically.

$$\begin{cases} y = 2x + 1 \\ x + y = 7 \end{cases}$$

$$\begin{array}{rr} -\cancel{x} & -x \\ \hline y = 7 - x & \end{array}$$

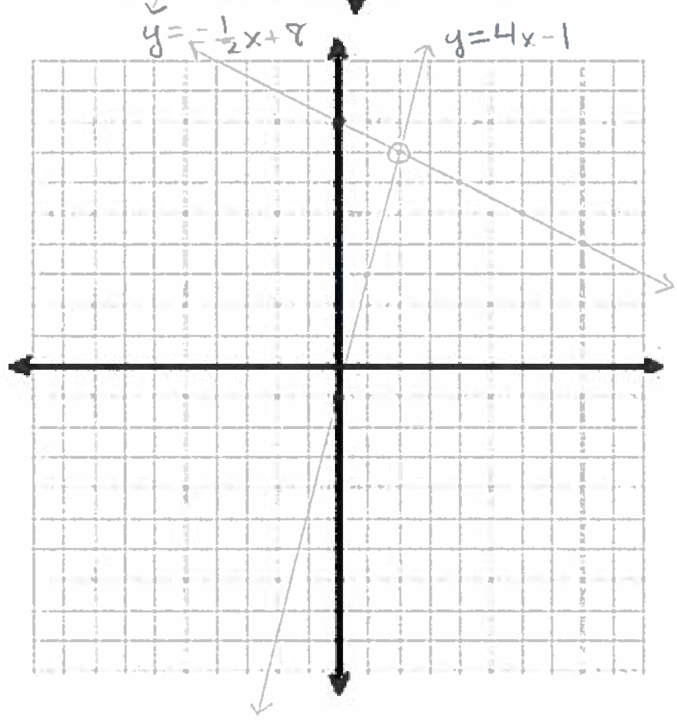
sol.: (2, 5)




Solve the system by graphing.

$$\begin{cases} y = 4x - 1 \\ y = -\dfrac{1}{2}x + 8 \end{cases}$$

sol.: (2,7)



## Guided Practice

1. $\begin{cases} 2x + y = 4 \\ 2x + 3y = 8 \end{cases}$

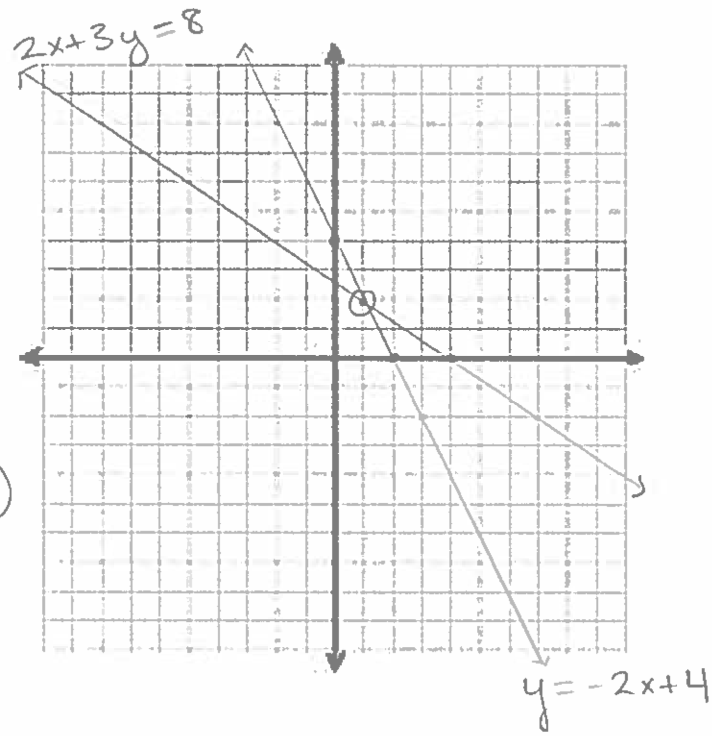
$2x + y = 4 \rightarrow y = -2x + 4$

$-2x \quad -2x$

$\frac{3y}{3} = \frac{-2x+8}{3}$

$y = -\frac{2}{3}x + \frac{8}{3}$

sol.: (1,2)



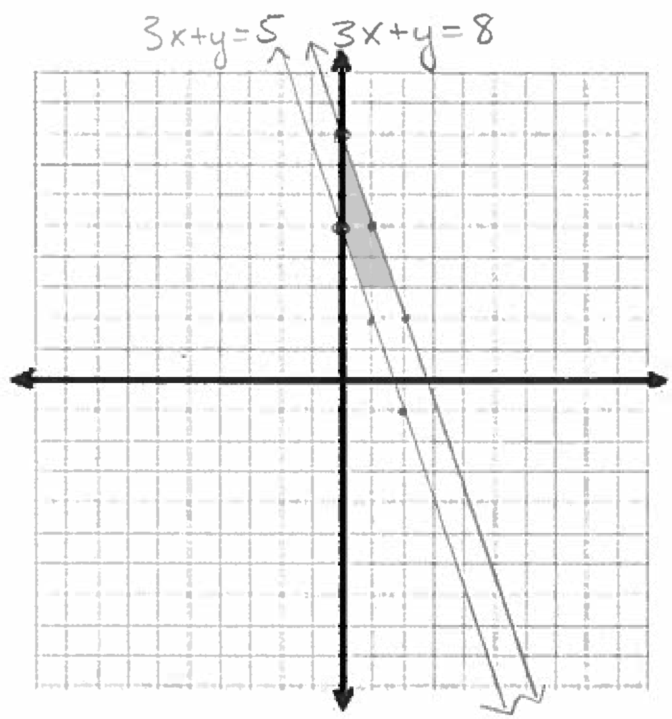

2. $\begin{cases} 3x + y = 5 \\ 3x + y = 8 \end{cases}$

$3x + y = 5 \rightarrow y = -3x + 5$

$3x + y = 8 \rightarrow y = -3x + 8$

lines have same slope, so they are parallel & never intersect

*no sol.



✓ **Self Assessment:**

Rate your level of understanding:

1 – confused  2 – somewhat understand it  3 – completely understand it

Questions?: ______________________________

**Guided Practice**

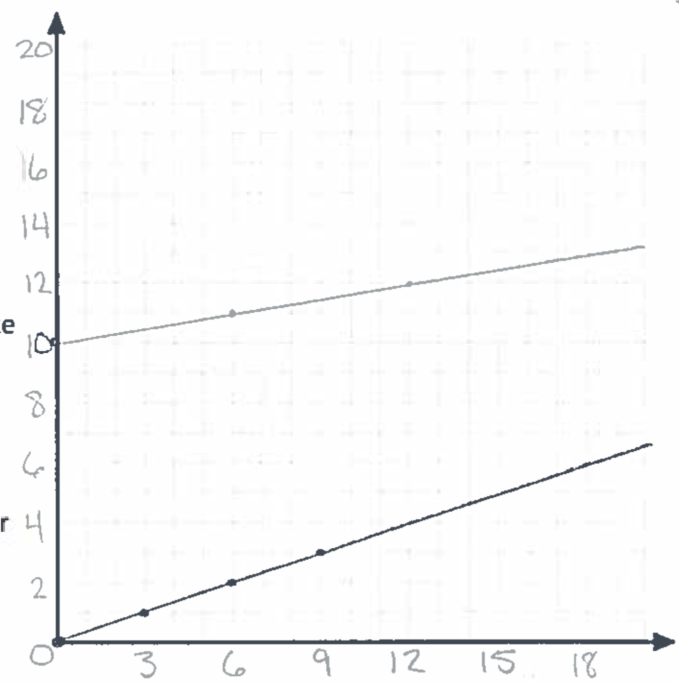
a. At the carnival, there is a game called the ring toss. If you toss the ring over the neck of a bottle, you win a prize. The cost is 3 throws for $1, but if have you a wristband, you get 6 throws for $1. The wristband costs $10.

i. Write two equations for the game in terms of the number of throws purchased – one with the wristband and one without the wristband.

with: $y = \frac{1}{6}x + 10$

without: $y = \frac{1}{3}x$

ii. Graph the two equations from part (a) on the same graph. Be sure to label the axes and use an appropriate scale.




iii. Does it make sense to buy the wristband? Explain your answer.

Not unless you're buying a high number of throws

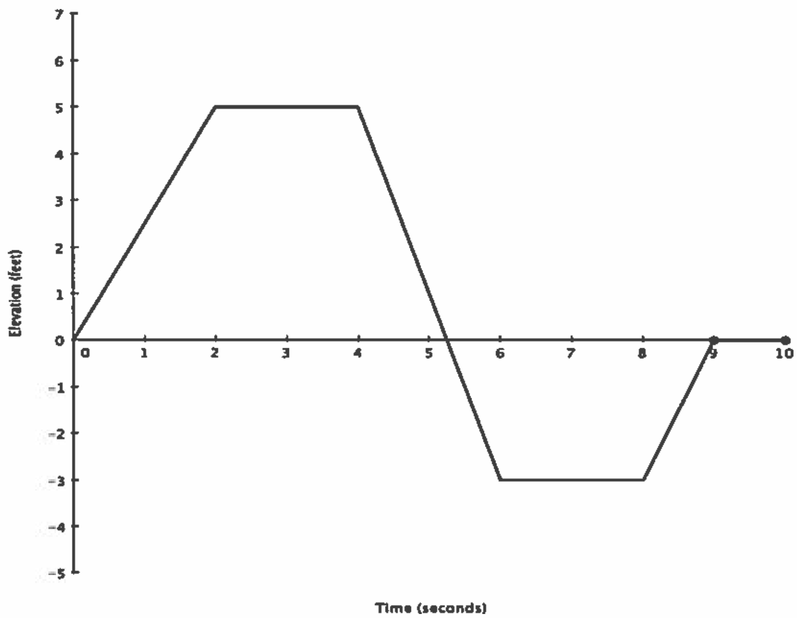
The intersection point of the graphs of the two equations is the ordered pair that is a solution to **BOTH** equations.

In other words, this is where the distance or elevation of both equations is equal.

Name: Key Date:__________

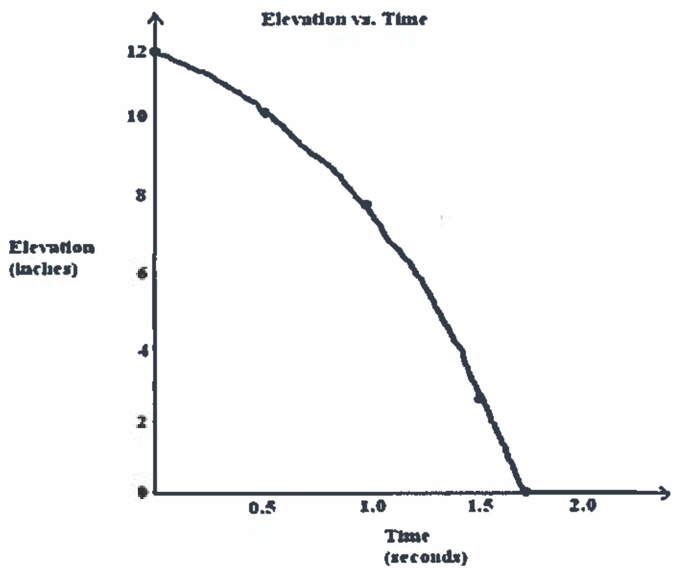
CW 3.2/3.3

1. Make up an elevation-versus-time graphing story for the following graph:




Answers will vary

2. Below is an elevation (in inches) versus time (in seconds) graph of a ball rolling down a ramp.




a. From about 1.7 seconds onwards, the graph is a horizontal (flat) line. If Calvin puts his foot on the ball at 2 seconds to stop the ball from rolling, how will the graph change?

The line won't continue past 2 seconds

b. Estimate the change in elevation (in inches) of the ball from 0 seconds to 0.5 seconds. Also estimate the change in elevation between 1.0 seconds and 1.5 seconds.

0-0.5 sec. → ≈ 2 in.

1.0-1.5 sec. → ≈ -.5 in

c. At what point is the speed of the ball the fastest? Near the top of the ramp at the beginning of its journey or near the bottom of the ramp at the end of its journey?

near the bottom

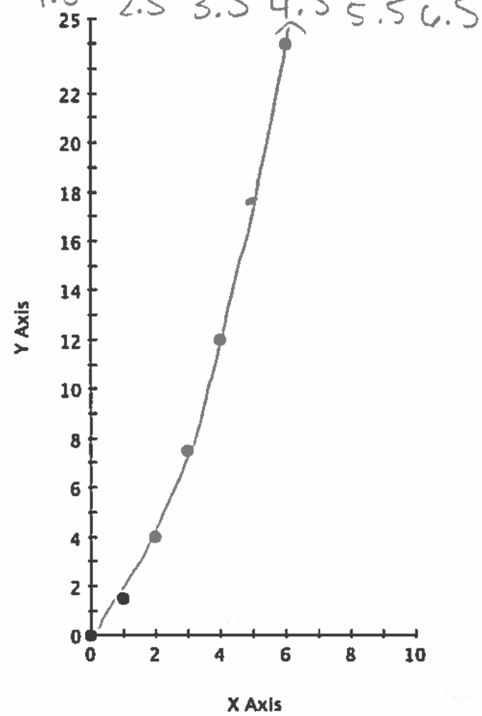
3. Use the table below to answer the following questions.

a. The points in this table (except when $x$ is 5 ) are plotted in the form $(x, y)$ on the graph below.

1 1 1 1 1 1

| $x$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| $y$ | 0 | 3/2 | 4 | 15/2 | 12 | 17.5 | 24 |

1.5 2.5 3.5 4.5 5.5 6.5




b. The $y$-values in the table follow a pattern. This pattern can be found by computing the differences between $y$-values. Find the pattern and use it to find the $y$ -value when $x$ is 5.

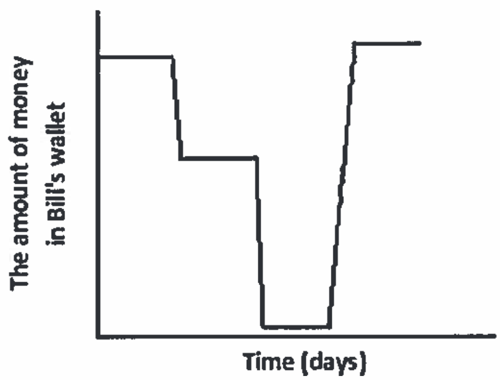
17.5

c. Plot the point you found in part (b). Now draw a curve through the points in your graph. Does the graph go through the point you plotted?

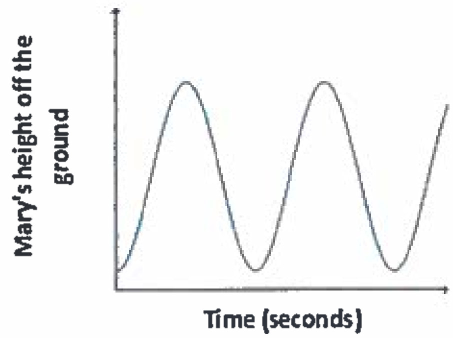
yes

4. Create a story to match each graph below:

a)




b)

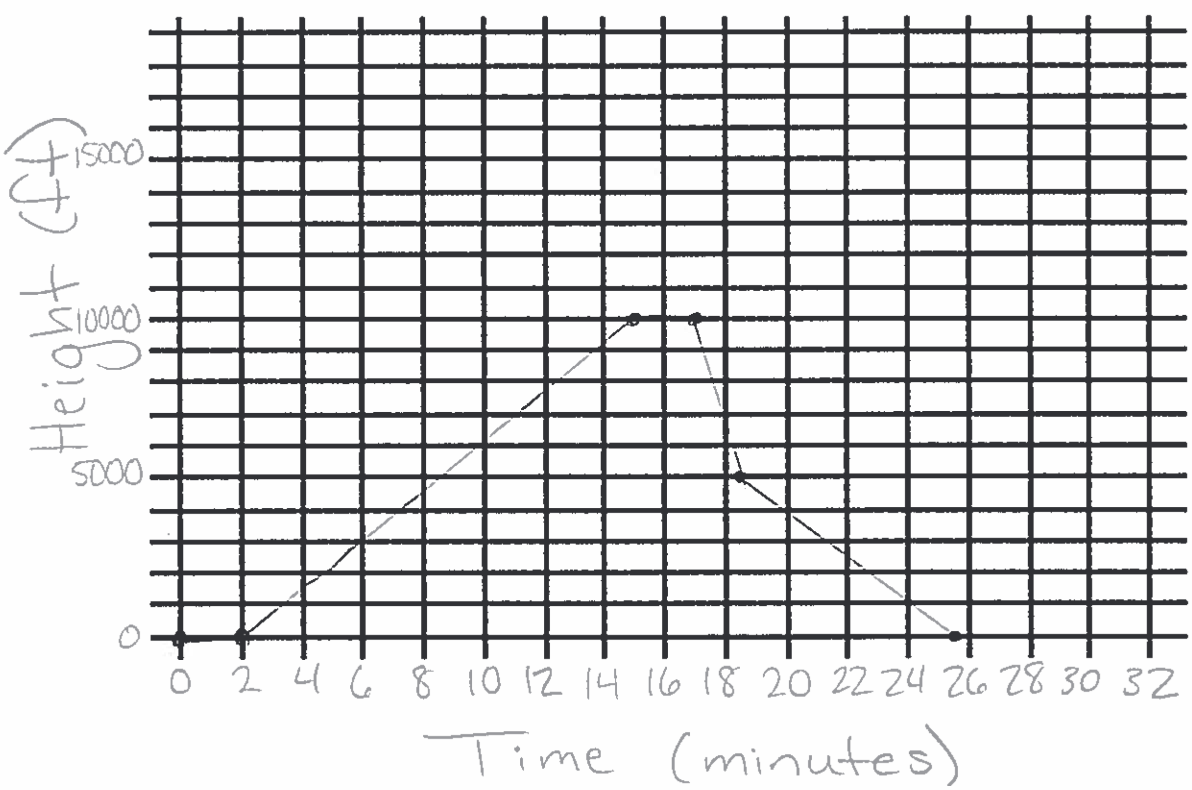



Answers will vary

5. Consider the following story about skydiving:

Dana gets into an airplane and waits patiently for 2 minutes before it takes off. The airplane climbs to 9,000 feet over the next 15 minutes. After 2 minutes at that constant elevation, Dana jumps and free falls for 45 seconds until she reaches a height of 5,000 feet. After deploying her chute, she slowly glides back to the ground. After 7 minutes, Dana lands gently on the ground.

Draw an elevation versus time graph to represent Dana's elevation with respect to time. Label both axes with an appropriate scale.



Name: Key

Quiz 3.2/3.3 A

Solve the system of linear equations graphically. Be sure to state your solution in coordinate form.

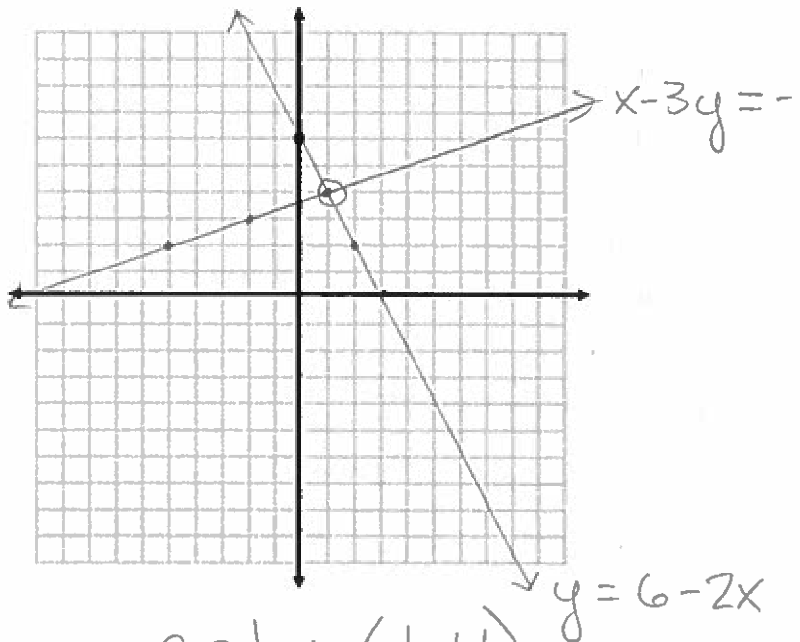
$2x + y = 6 \rightarrow y = 6 - 2x$

$x - 3y = -11$

$\hookrightarrow \frac{-3y}{-3} = \frac{-11 - x}{-3}$

$y = \frac{1}{3}x + \frac{11}{3}$

| x | y |
|---|---|
| -5 | 2 |
| -2 | 3 |
| 1 | 4 |
| 4 | 5 |




sol.: (1,4)

Name: Key

Quiz 3.2/3.3 B

Solve the system of linear equations graphically. Be sure to state your solution in coordinate form.

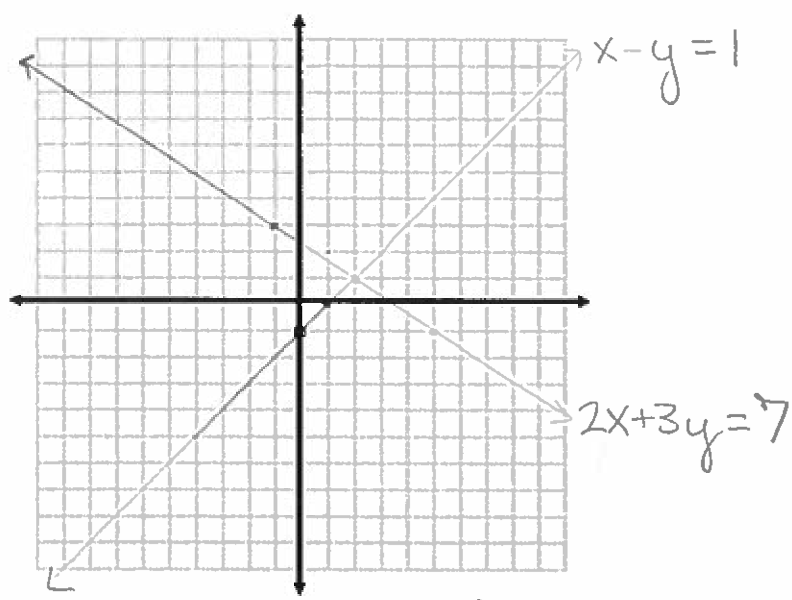
$2x + 3y = 7 \rightarrow \frac{3y}{3} = \frac{-2x+7}{3}$

$x - y = 1$

$\hookrightarrow y = x - 1$

$y = -\frac{2}{3}x + \frac{7}{3}$

| x | y |
|---|---|
| -1 | 3 |
| 2 | 1 |
| 5 | -1 |




sol.: (2,1)

## Algebra
## Unit 3 – Lesson 4 – Solving Linear Systems Algebraically

Name: Key

Date: ____________

**Lesson Objectives:**

- I can solve linear systems using the substitution method
- I can solve linear systems using the elimination method
- I understand that a solution to a linear system is a point, infinitely many points, or no solution.

**Concept Development:**

When we multiply both or one equation by a constant, we are using an algebraic method of solving known as **elimination.** The basic idea of elimination is that when we multiply both sides of the equation by a constant, the equation actually remains the same. We use this to help us to eliminate one variable, allowing us to solve the equation that is left.

Solve this system of linear equations algebraically.

| ORIGINAL SYSTEM | NEW SYSTEM | SOLUTION |
|---|---|---|
| $2x + y = 6$<br>$-2(x - 3y = -11)$ | $\cancel{2x} + y = 6$<br>$\cancel{-2x} + 6y = 22$<br>$7y = 28$<br>$\frac{7y}{7} = \frac{28}{7}$<br>$y = 4$ | $(1, 4)$ |

plug back in:

$2x + y = 6$

$2x + \cancel{4} = 6$

$\cancel{-4} \quad -4$

$2x = 2$

$\frac{2x}{2} = \frac{2}{2}$

$x = 1$

* you can check by plugging into both original equations & making sure your solution work

**Exercise 1:**

Use **elimination** to create a new system of equations with the same solution as the original that eliminates variable $y$ from one equation, then determine the solution.

ORIGINAL SYSTEM

$2x + 3y = 7$

$3(x - y = 1)$

NEW SYSTEM

$2x + \cancel{3y} = 7$

$+\ 3x - \cancel{3y} = 3$

$\frac{5x}{5} = \frac{10}{5}$

$x = 2$

$x - y = 1$

$2 - y = 1$

$-1 + y \quad -1 + y$

$1 = y$

SOLUTION

$(2, 1)$

**Exercise 2:**

Use **elimination** to create a new system of equations with the same solution as the original that eliminates variable $x$ from one equation, then determine the solution.

ORIGINAL SYSTEM

$2x + 3y = 7$

$-2(x - y = 1)$

NEW SYSTEM

$\cancel{2x} + 3y = 7$

$-\cancel{2x} + 2y = -2$

$\frac{5y}{5} = \frac{5}{5}$

$y = 1$

$x - y = 1$

$x - 1 = 1$

$+1 \quad +1$

$x = 2$

SOLUTION

$(2, 1)$

**→What do you notice about the solutions to exercises 1 and 2?**

they are the same!

**Exercise 3:**

Use **elimination** to create a new system of equations with the same solution as the original that eliminates variable $x$ from one equation, then determine the solution.

ORIGINAL SYSTEM

5x – 2y = 7

$-\frac{5}{2}($2x + 3y = 18$)$

NEW SYSTEM

$\cancel{5x} - 2y = 7$

$-\cancel{5x} - \frac{15}{2}y = -45$

$-\frac{2}{19}\left(\frac{-19}{2}y\right) = (-38)\frac{2}{-19}$

$y = 4$

$5x - 2y = 7$

$5x - 2(4) = 7$

$5x - 8 = 7$

$+8 \quad +8$

$\frac{5x}{5} = \frac{15}{5}$

$x = 3$

SOLUTION

$(3, 4)$

✓ **Self Assessment:**

Rate your level of understanding:

1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ______________________________

Another method of solving linear systems is through a method known as **substitution.** In substitution, you simply replace an expression with one that is equivalent to help you to solve for the missing variables.

In order for substitution to be effective, you must have one equation set equal to x or y. In other words, x or y must be isolated.

**Example:**

Solve the following system of equations by substitution.

$$\begin{cases} y = 2x + 1 \\ x - y = 7 \end{cases}$$

$x - (2x+1) = 7$

$x - 2x - 1 = 7$

$-x - \cancel{1} = 7$

$+\cancel{1} \quad +1$

$\frac{-x}{-1} = \frac{8}{-1}$

$x = -8$

$y = 2x + 1$

$y = 2(-8) + 1$

$y = -16 + 1$

$y = -15$

$(-8, -15)$

**Guided Practice**

1. $\begin{cases} y = 4x - 1 \\ y = -\frac{1}{2}x + 8 \end{cases}$

$4x \cancel{- 1} = -\cancel{\frac{1}{2}x} + 8$

$+\frac{1}{2}x + \cancel{1} \quad +\cancel{\frac{1}{2}x} + 1$

$\cancel{\frac{2}{9}}\left(\cancel{\frac{9}{2}}x\right) = (\cancel{9})\frac{2}{\cancel{9}}$

$x = 2$

$y = 4x - 1$

$y = 4(2) - 1$

$y = 8 - 1$

$y = 7$

$(2, 7)$

2. $\begin{cases} 2x + y = 4 \\ \cancel{2x + 3y = 9} \end{cases}$ rearrange $y = -2x + 4$

$2x + 3(-2x+4) = 9$

$2x - 6x + 12 = 9$

$-4x + \cancel{12} = 9$

$-\cancel{12} \quad -12$

$-4x = -3$

$\frac{-4x}{-4} = \frac{-3}{-4}$

$x = 3/4$

$\left(\frac{3}{4}, \frac{5}{2}\right)$

$2x + 3y = 9$

$2(3/4) + 3y = 9$

$\cancel{\frac{3}{2}} + 3y = 9$

$-\cancel{3/2} \quad -3/2$

$\cancel{\frac{1}{3}}(\cancel{3}y) = \left(\frac{15}{2}\right)\frac{1}{3}$

$y = \frac{5}{2}$

**Word Problems:**

1. Rick and Anita are comparing bank accounts. Rick says, "The sum of your bank account and twice mine is 361 dollars." Anita replies, "The sum of your bank account and twice mine is 362 dollars." Find the amount in each of their bank accounts.

$y + 2x = 361$

$-2(x + 2y = 362)$

$y + \cancel{2x} = 361$

$-4y - \cancel{2x} = -724$

$\frac{-3y}{-3} = \frac{-363}{-3}$

$y = 121$

$y + 2x = 361$

$\cancel{121} + 2x = 361$

$-\cancel{121} \quad -121$

$\frac{2x}{2} = \frac{240}{2} \to x = 120$

Rick: \$120

Anita: \$121

2. A cafeteria serves 2 types of chocolate milk: one with 60% milk and one with 75% milk. DeVaughn wants 120 ml of chocolate milk with 70% milk. How many ml of each type of chocolate milk does he need to mix?

$x + y = 120$

$y = 120 - x$

$.60x + .75(120 - x) = .70(120)$

$.60x + 90 - .75x = 84$

$-.15x + \cancel{90} = 84$

$-\cancel{90} \quad -90$

$\frac{-\cancel{.15}x}{-\cancel{.15}} = \frac{-6}{-.15}$

$x = 40$ mL of 60% milk

$y = 80$ mL of 75% milk

3. Paul has two part time jobs. At one job, he works as a janitor and makes \$10 per hour. At the second job, he works as a bank teller and makes \$15 per hour. One week he worked 40 hours and made \$475. How many hours did he work at each job?

$x =$ hours (janitor)

$y =$ hours (bank teller)

$-10(x + y = 40)$

$10x + 15y = 475$

$$\begin{array}{r} \cancel{10x} + 15y = 475 \\ -\cancel{10x} - 10y = -400 \\ \hline \frac{5y}{5} = \frac{75}{5} \\ y = 15 \end{array}$$

$$\begin{array}{r} x + y = 40 \\ x + \cancel{15} = 40 \\ -\cancel{15} \quad -15 \\ \hline x = 25 \end{array}$$

25 hours as a janitor, 15 hours as a bank teller

✓ **Self Assessment:**

Rate your level of understanding:

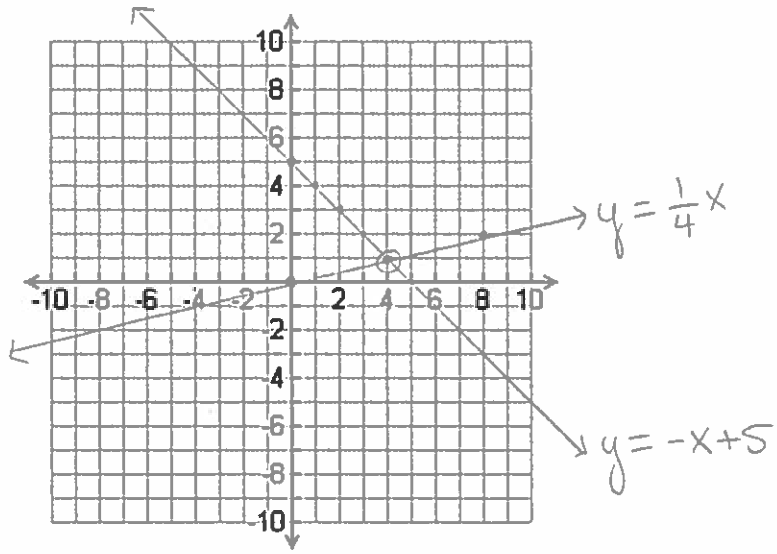
1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ______________________________

Name: Key  Date:

CW 3.4

1. a) Solve the system of equations: $\begin{cases} y = \frac{1}{4}x \\ y = -x + 5 \end{cases}$ by graphing.




b) Solve the system above using the substitution method.

$\frac{1}{4}x = -\cancel{x} + 5$

$+x \quad \cancel{+x}$

$\cancel{\frac{4}{5}}\left(\cancel{\frac{5}{4}}x\right) = (5)\cancel{\frac{4}{5}}$

$x = 4$

$y = \frac{1}{4}x$

$y = \frac{1}{4}(4)$

$y = 1$

$\boxed{(4, 1)}$

2. Solve each system of equations by elimination.

a) $-2(2x + y = 25)$

$\cancel{4x} + 3y = 9$

$\cancel{-4x} - 2y = -50$

$y = -41$

$2x + y = 25$

$2x - 41 = 25$

$\cancel{+41} \quad +41$

$\frac{\cancel{2}x}{\cancel{2}} = \frac{66}{2}$

$x = 33$

$\boxed{(33, -41)}$

b) $\frac{-7}{2}(3x + 2y = 4)$

$4x + 7y = 1$

$-\frac{21}{2}x - 7y = -14$

$\frac{2}{-13}\left(-\frac{13}{2}x\right) = (-13)\frac{2}{-13}$

$x = 2$

$3x + 2y = 4$

$3(2) + 2y = 4$

$6 + 2y = 4$

$-6 \qquad -6$

$\frac{2y}{2} = \frac{-2}{2}$

$y = -1$

$\boxed{(2, -1)}$

3. Solve the following using substitution.

$4x + 3y = 9$

$2x + y = 25 \rightarrow y = 25 - 2x$

$4x + 3(25 - 2x) = 9$

$4x + 75 - 6x = 9$

$-2x + 75 = 9$

$-75 \quad -75$

$\frac{-2x}{-2} = \frac{-66}{-2}$

$x = 33$

$2x + y = 25$

$2(33) + y = 25$

$66 + y = 25$

$-66 \qquad -66$

$y = -41$

$\boxed{(33, -41)}$

4. A chemist has two solutions: a 50% ether solution and an 80% ether solution. She wants 100 ml of a 70% ether solution. How many ml of each solution does she need to mix?

$.5x + .8y = .7(100) \longrightarrow .5(100 - y) + .8y = 70$

$x + y = 100 \rightarrow x = 100 - y$

$50 - .5y + .8y = 70$

$-50 \qquad\qquad -50$

$\frac{.3y}{.3} = \frac{20}{.3}$

$y = \frac{200}{3}$

$x = 100 - \frac{200}{3}$

$x = \frac{100}{3}$

$\frac{100}{3}$ of 50% ether
& $\frac{200}{3}$ of 80% ether

5. Kenzie has two part time jobs. At one job, she babysits for a local family and makes $8 per hour. At a grocery store, she works as a cashier and makes $12 per hour. One week she worked 30 hours and made $268. How many hours did Kenzie work at each job?

$x$ = babysitting hours
$y$ = cashier hours
$x + y = 30 \rightarrow x = 30 - y$
$8x + 12y = 268$

$8x + 12y = 268$
$8(30 - y) + 12y = 268$
$\cancel{240} - 8y + 12y = 268$
$-\cancel{240} \qquad -240$
$\frac{\cancel{4}y}{\cancel{4}} = \frac{28}{4}$
$y = 7$

$x + y = 30$
$x + \cancel{7} = 30$
$-\cancel{7} \quad -7$
$x = 23$

$\boxed{\text{23 hours babysitting, } \cancel{8}\ \text{7 hours as a cashier}}$

6. A grocery store sells caramel syrup for $10 per pound and chocolate syrup for $14 per pound. If they decide to make a 150-lb. blend of the two syrups and sell it for $11 per pound, how much of each type of syrup should be used?

$x$ = caramel syrup
$y$ = chocolate syrup
$x + y = 150 \rightarrow y = 150 - x$
$10x + 14y = 11(150)$

$10x + 14y = 11(150)$
$10x + 14(50 - x) = 1650$
$10x + \cancel{2100} - 14x = 1650$
$-\cancel{2100} \qquad -2100$
$\frac{-\cancel{4}x}{-\cancel{4}} = \frac{-450}{-4}$
$x = 112.5$

$x + y = 150$
$\cancel{112.5} + y = 150$
$-\cancel{112.5} \qquad -112.5$
$y = 37.5$

$\boxed{\text{112.5 pounds of caramel syrup, 37.5 pounds of chocolate syrup}}$

Name: Key

3.4 Quiz A

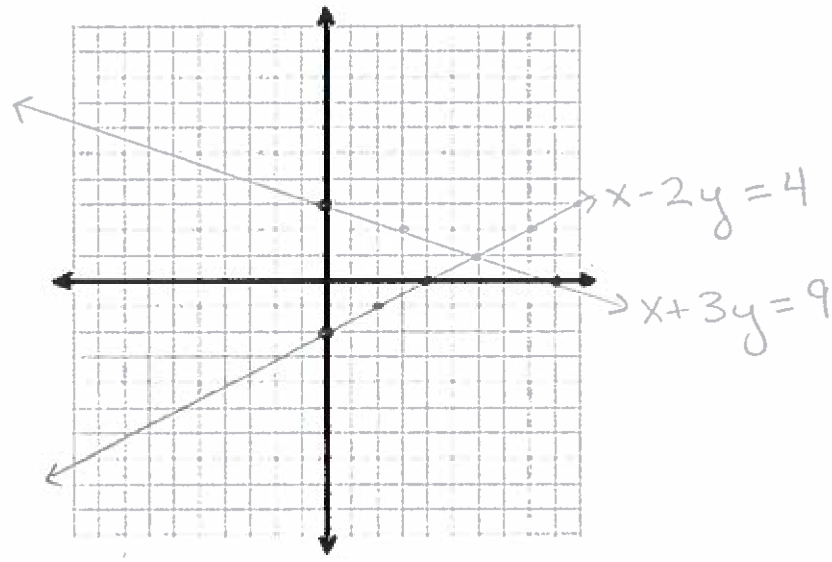
Solve the following system of equations by graphing. $\begin{cases} x - 2y = 4 \\ x + 3y = 9 \end{cases}$

$x - \cancel{2y} = \cancel{4}$

$\underline{-4 + \cancel{2y} \quad \cancel{-4} + 2y}$

$\frac{x}{2} - \frac{4}{2} = \frac{2y}{2}$

$y = \frac{1}{2}x - 2$




$\cancel{x} + 3y = 9$

$\underline{\cancel{-x} \qquad -x}$

$\frac{3y}{3} = \frac{9-x}{3}$

$y = -\frac{1}{3}x + 3$

Name: Key

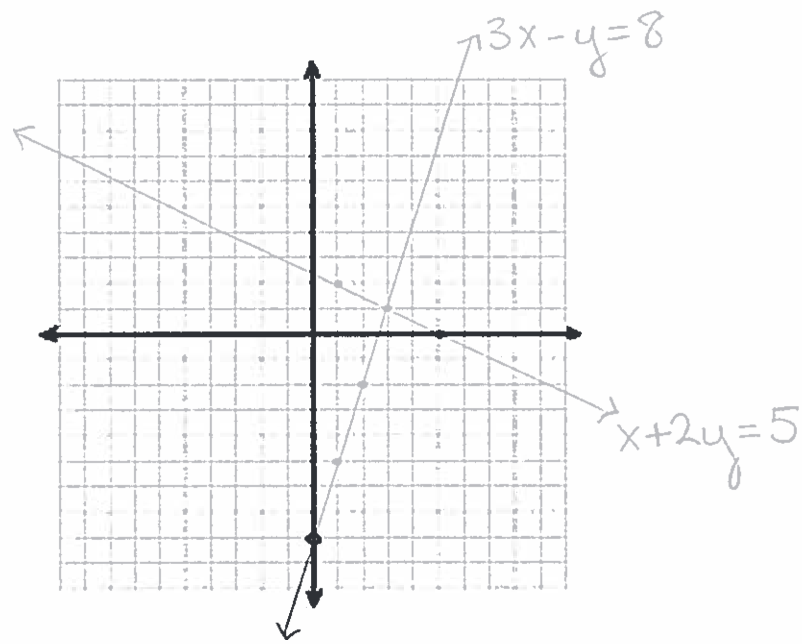
3.4 Quiz B

Solve the following system of equations by graphing $\begin{cases} 3x - y = 8 \\ x + 2y = 5 \end{cases}$

$3x - \cancel{y} = \cancel{8}$

$\underline{-8 + \cancel{y} \quad \cancel{-8} + y}$

$y = 3x - 8$




$\cancel{x} + 2y = 5$

$\underline{\cancel{-x} \qquad -x}$

$\frac{2y}{2} = \frac{5-x}{2}$

$y = -\frac{1}{2}x + \frac{5}{2}$

# Algebra

## Unit 3 – Lesson 5 – Solving Linear Inequalities

Name: Key  Date: ________________

**Lesson Objectives:**

- I can graph linear inequalities
- I can graph systems of linear inequalities
- I understand that the shaded region represents all possible solutions to a problem

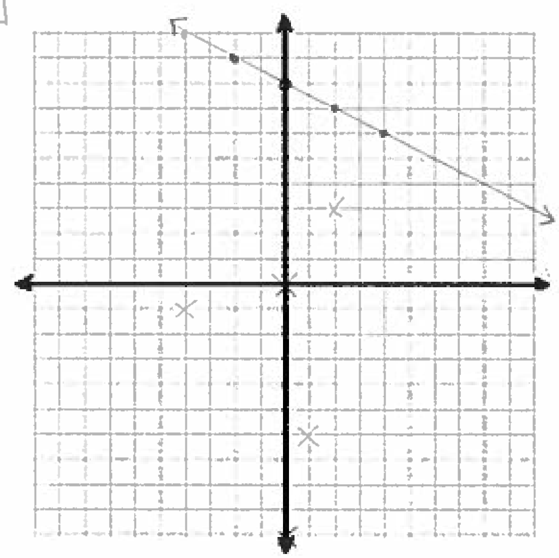
**Accessing Prior Knowledge:**

a. **Circle** each ordered pair $(x, y)$ that is a solution to the equation $-\frac{1}{2}x = y - 8$.

**Box** in each ordered pair (x, y) that is a solution to the inequality $-\frac{1}{2}x \geq y - 8$.

(0,8)  $\boxed{(2,3)}$  (−2,9)  $\boxed{(0,0)}$  $\boxed{(1,-6)}$

(−4,10)  $\boxed{(0,-10)}$  $\boxed{(3,4)}$  (2,7)  $\boxed{(-4,-1)}$



b. Plot the points above that are circled with a dot.

Plot the points above that are boxed in with an x.

c. Connect the points that are dots. You should notice that a line is created. What do you notice about the location of all of the points plotted with an x?

they are all to the left of (beneath) the line

**Concept Development:**

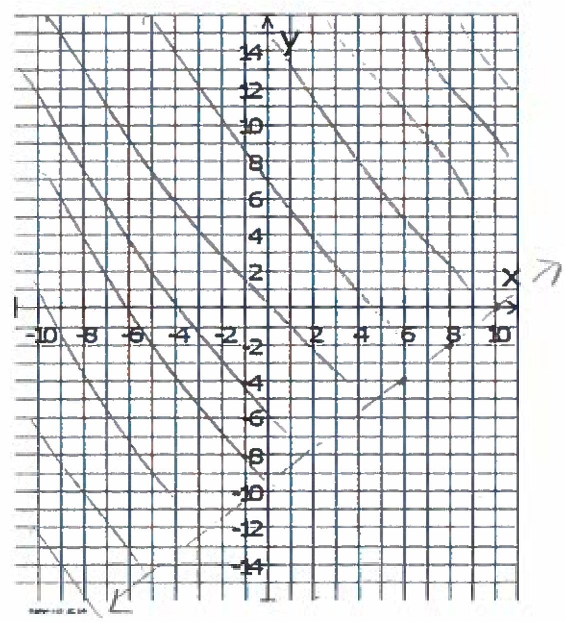
In general, when you are graphing linear inequalities, you need to follow the following steps:

1) Graph the equation as if the symbol is =, not an inequality symbol.
2) Decide whether the line should be dotted (this is true if the inequality sign is < or >) or solid (this is true if the inequality sign is ≥ or ≤)
3) Test a point. Generally we test (0,0). If the point makes the inequality true, shade in that direction. If the point makes the inequality false, shade away from that direction.

dotted: < or > solid: ≤ or ≥

Plot the solution sets to the following equations and inequalities:

1. $x - y < 10$




a) Graph the line $x - y = 10$

$-10 + y \quad -10 + y$

$x - 10 = y$

b) Is the line going to be dotted or solid??

c) Test the point (0,0). If it is in the solution set, then shade in That direction.

✓ **Self Assessment:**

Rate your level of understanding:

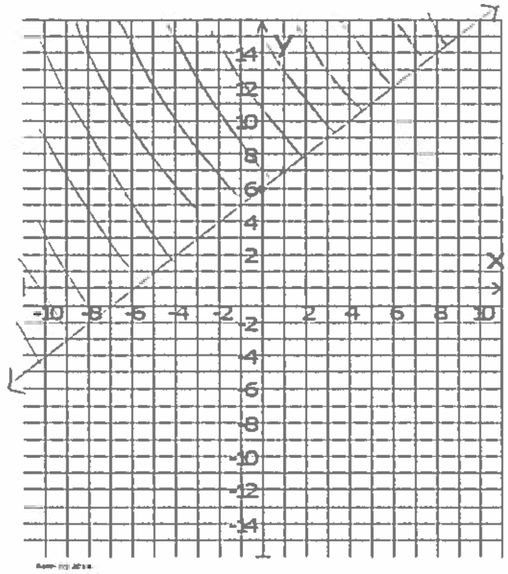
1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ______________________________________________

**Guided Practice:**

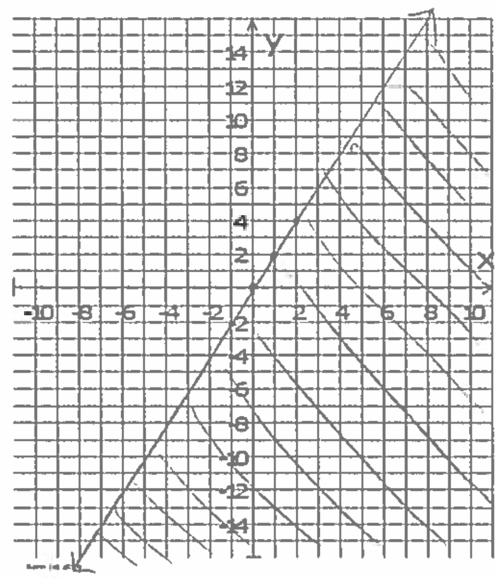
2. $y \geq x + 6$

- graph $y = x + 6$
- solid or dotted?
- test $(0,0)$

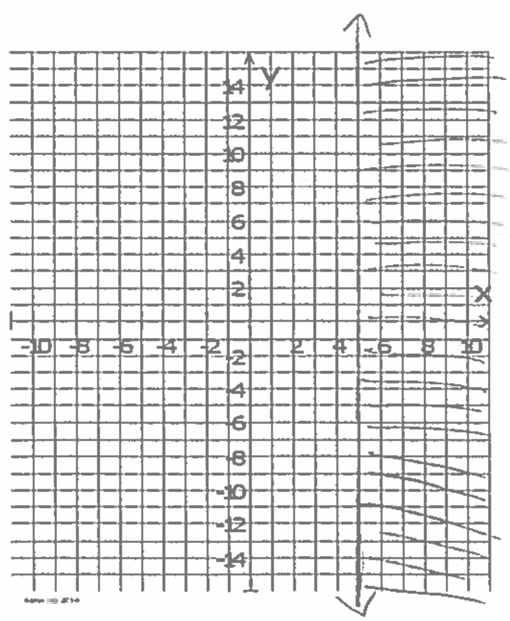


3. $2x \geq y$

*since $(0,0)$ is on the line, we must test a different point



4. $x \geq 5$



## Concept Development

You can also graph systems of linear inequalities. To do so, basically just graph both inequalities on the same graph. When you shade, the area that is double shaded is the area that is now the solution set. We label that area with an **S**.

Graph the solution set to the system of inequalities.

$2x - y < 3$ and $4x + 3y \geq 0$

$2x < 3 + y$

$2x - 3 < y$

dotted

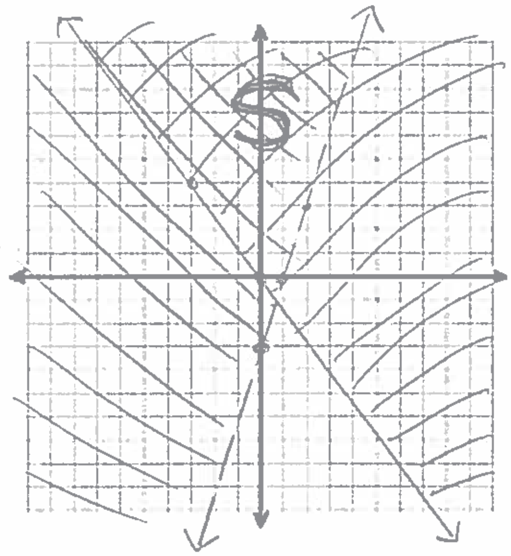
| x | y |
|---|---|
| -1 | -6 |
| 0 | -3 |
| 1 | 0 |
| 2 | 3 |

$3y \geq -4x$

$y \geq -\frac{4}{3}x$

solid

| x | y |
|---|---|
| -6 | 8 |
| -3 | 4 |
| 0 | 0 |




Give an example of a point that is in the solution set. (1, 1)

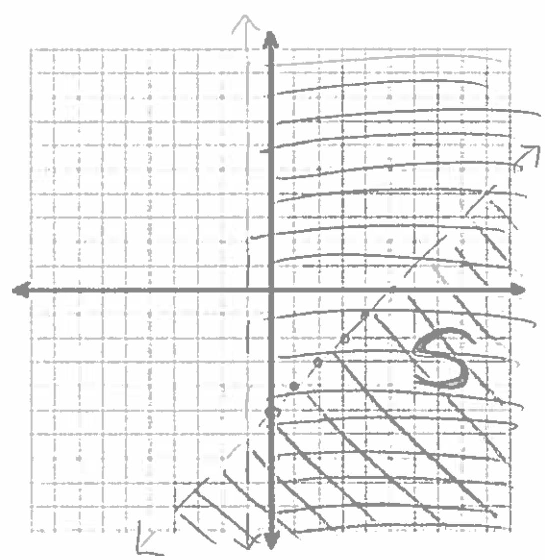
Give an example of a point that is NOT in the solution set. (2, -5)

## Guided Practice:

Graph the solution set to each system of inequalities.

d. $\begin{cases} x - y > 5 \\ x > -1 \end{cases}$ $\longrightarrow y < x - 5$

| x | y |
|---|---|
| 0 | -5 |
| 1 | -4 |
| 2 | -3 |



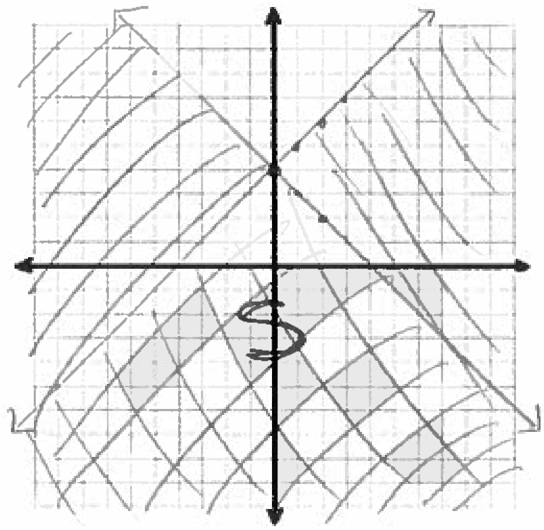
5. $\begin{cases} y \le x + 4 \\ y \le 4 - x \\ y \ge 0 \end{cases}$

$x + 4$

| x | y |
|---|---|
| -2 | 2 |
| -1 | 3 |
| 0 | 4 |
| 1 | 5 |
| 2 | 6 |

$4 - x$

| x | y |
|---|---|
| -1 | 5 |
| 0 | 4 |
| 1 | 3 |
| 2 | 2 |




Give an example of a point that is in the solution set. (1,2)

Give an example of a point that is NOT in the solution set. (-6,0)

✓ **Self Assessment:**

Rate your level of understanding:

1 – confused 2 – somewhat understand it 3 – completely understand it

Questions?: ____________________

Name: Key Date: ______________

CW 3.5

1. Match each inequality with its graph.

a. $2x - y > 6$

2

b. $y \leq 2x - 6$

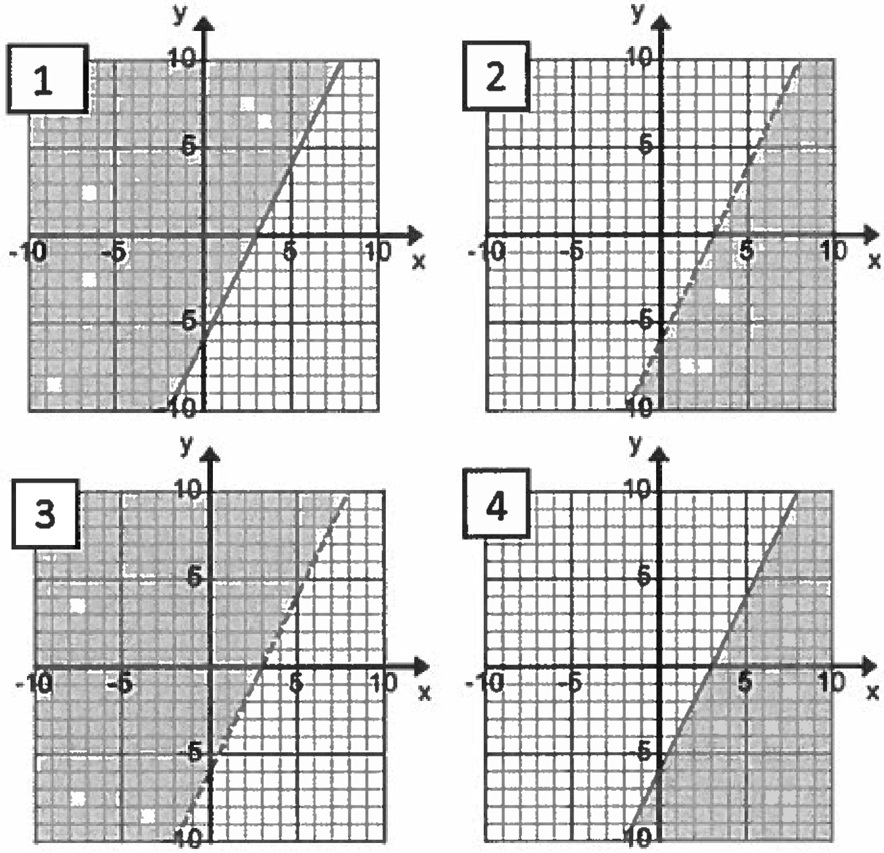
4

c. $2x < y + 6$

3

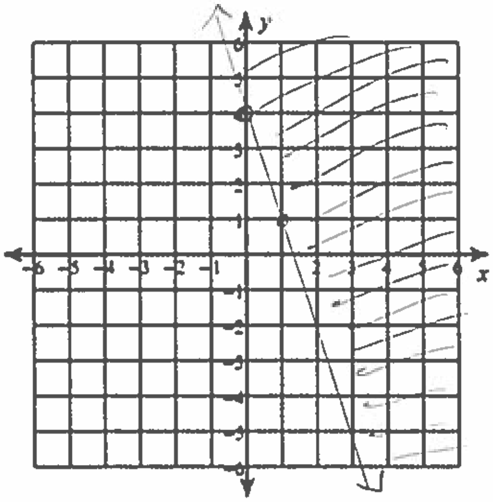
d. $2x - 6 \leq y$

1

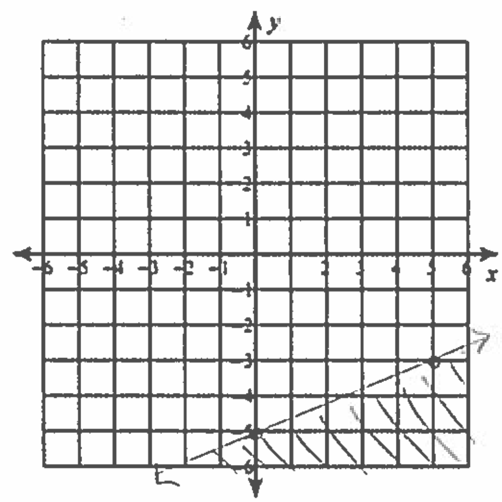


2. Graph the solution set in the coordinate plane.

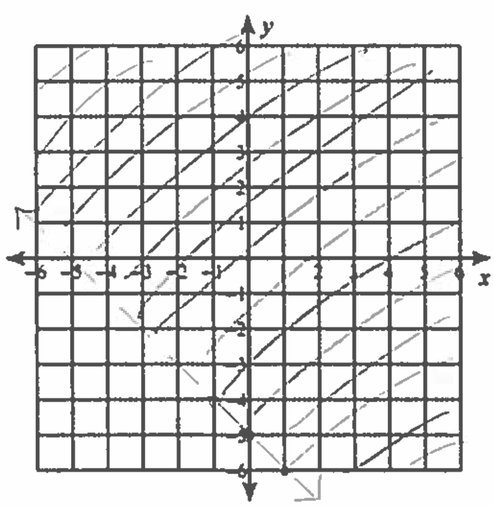
1) $y \geq -3x + 4$



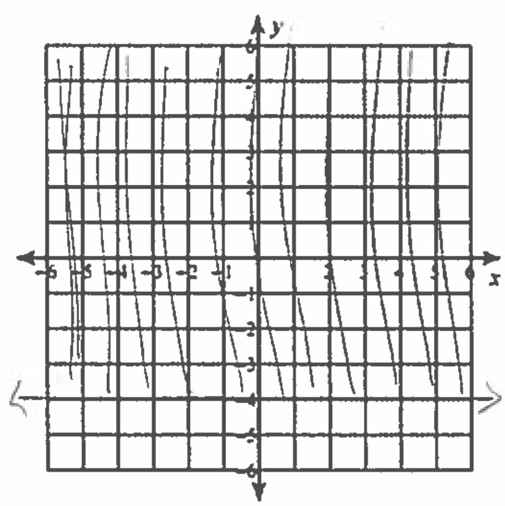
2) $y \leq \frac{3}{5}x - 5$



3) $y > -x - 5$

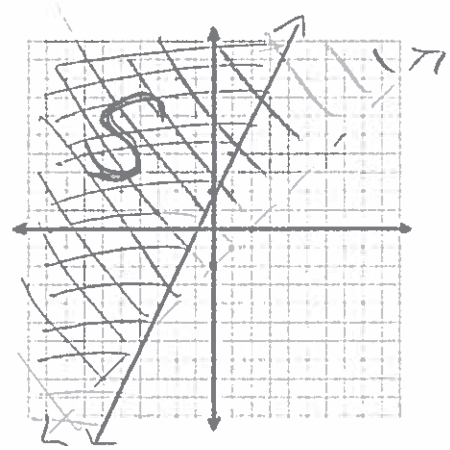


4) $y > -4$



3. Graph the solution to the following system of inequalities:

$$\begin{cases} y > x - 2 \\ y \leq 2x + 2 \end{cases}$$




4. Graph the solution to the following system of inequalities:

$$\begin{aligned} x &\geq -1 \\ 2x - 3y &\leq 2 \\ x + y &> 1 \end{aligned}$$

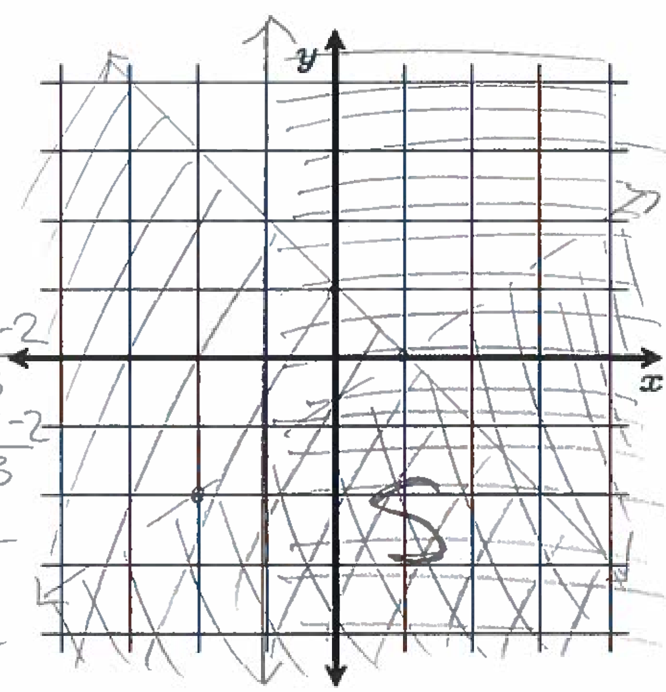
$\frac{3y}{3} \geq \frac{2x-2}{3}$

$y \geq \frac{2x-2}{3}$

| x | y |
|---|---|
| -5 | -4 |
| -2 | -2 |
| 1 | 0 |
| 4 | 2 |
| 7 | 4 |

$y > 1 - x$

| x | y |
|---|---|
| -2 | 3 |
| -1 | 2 |
| 0 | 1 |
| 1 | 0 |
| 2 | -1 |



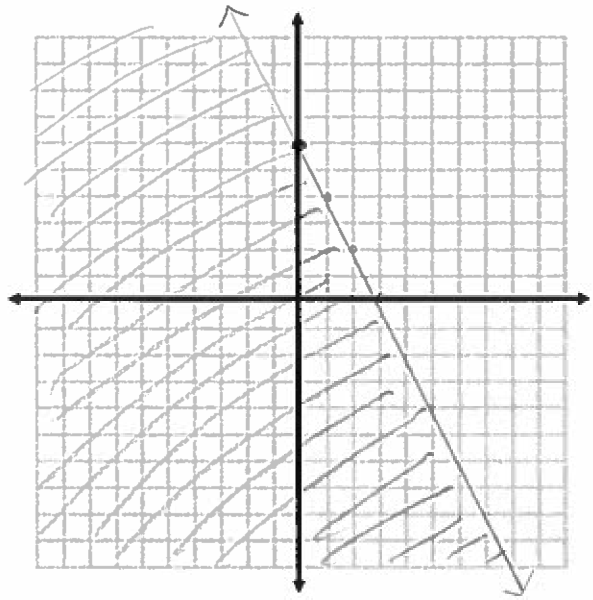
Name: Key

Quiz 3.5 A

Plot the solution set to the following inequality. (Graph the line...is it dotted or solid? Then test a point.)

$2x + y \leq 6$

$y \leq 6 - 2x$



Name: Key

Quiz 3.5 B

Plot the solution set to the following inequality. (Graph the line...is it dotted or solid? Then test a point.)

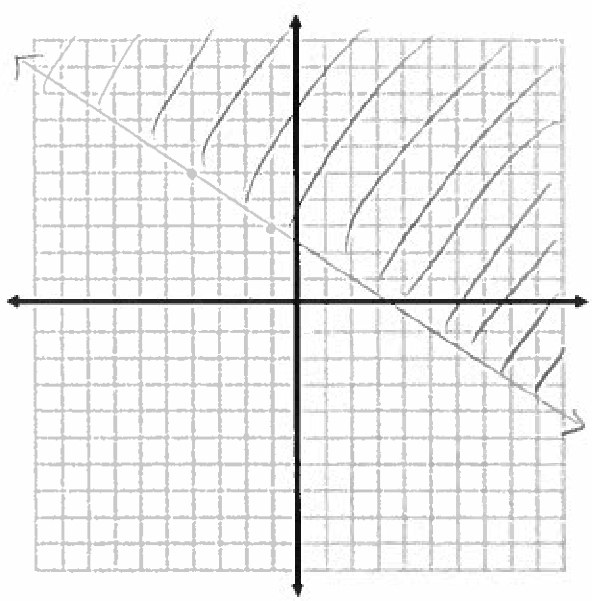
$2x + 3y \geq 7$

$-2x \quad -2x$

$\frac{3y}{3} \geq \frac{7-2x}{3}$

$y \geq \frac{7}{3} - \frac{2}{3}x$

| x | y |
|---|---|
| -4 | 5 |
| -1 | 3 |
| 2 | 1 |
| 5 | -1 |
| 8 | -3 |



**Algebra**

**Unit 3 – Lesson 6 – Systems of Linear Inequalities Word Problems**

Name: Key

Date: ____________

## Lesson Objectives:

- I can solve systems of linear inequalities by graphing
- I can create inequalities based on a word problem
- I can identify constraints for a problem using the description of the word problem.

## Concept Development:

A baker has 1000 pounds of dough to make snowman cookies and star cookies. A snowman requires 1 pound of dough and a star cookie requires 2 pounds of dough. It takes 2 hours to make a snowman and 3 hours to make a star. There are 1600 hours available to make the cookies.

i. What are the variables?

$x$ = # snowmen

$y$ = # stars

ii. What are the constraints?

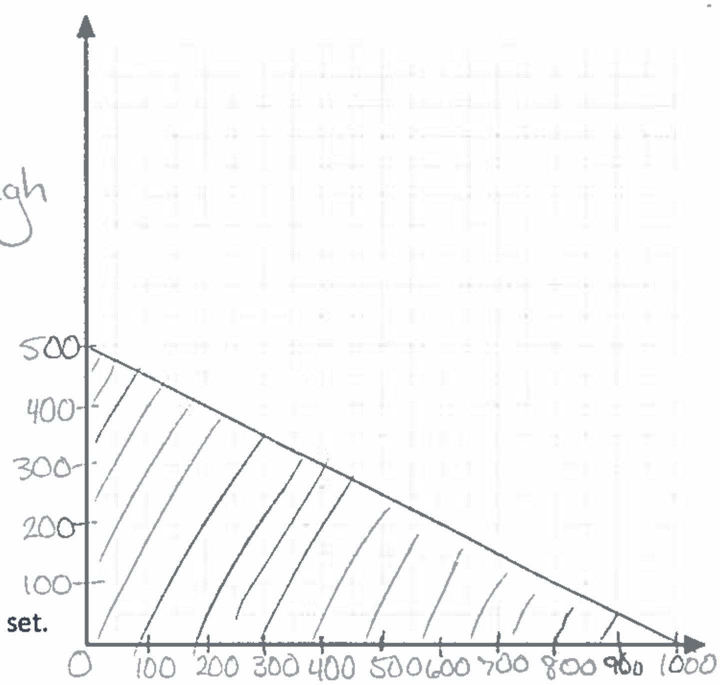
1000 lbs of dough

1600 hrs

iii. Write inequalities for the constraints.

$1x + 2y \leq 1000$

$2x + 3y \leq 1600$




iv. Graph the inequalities and shade the solution set.

v. What does the shaded region represent?

possible solutions

## Guided Practice:

1. You are shopping for chips and soda at a grocery store. Each bag of chips costs $4 and each bottle of soda costs $2. You don't want to buy more than 20 bags of chips and bottles of soda together, and you have a $50 budget. Find a system of inequalities representing the number of snacks you could buy.

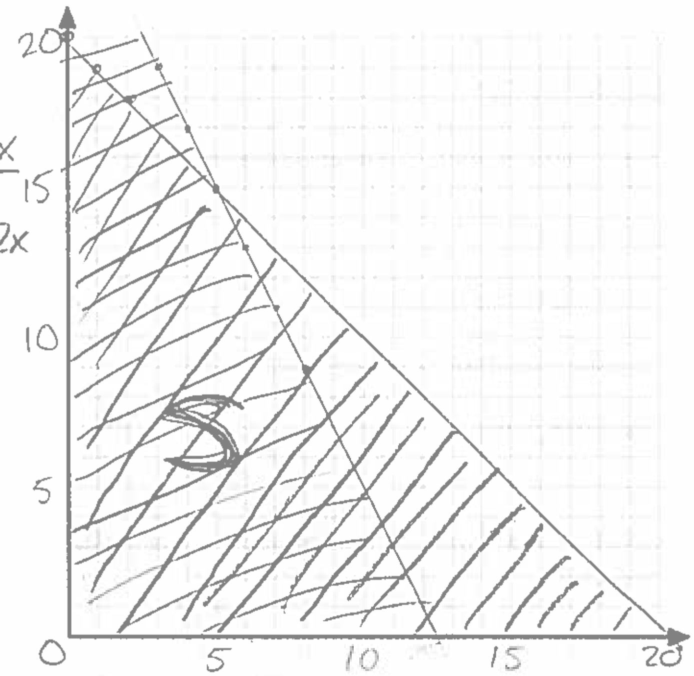
x = # of bags of chips
y = # of bottles of soda

$4x+2y \le 50 \rightarrow \frac{2y}{2} \le \frac{50-4x}{2}$

$y \le 25-2x$

$x+y \le 20$

$\hookrightarrow y \le 20-x$




2. Nadine is having a graduation party. She needs to buy decorations for the party and dinnerware for her guests. Her car can hold up to 10 boxes. Each box of decorations costs $100 and each box of dinnerware costs $150. A maximum of $1200 is budgeted for this party. Write a system of inequalities that represents how many of each box Nadine should order.

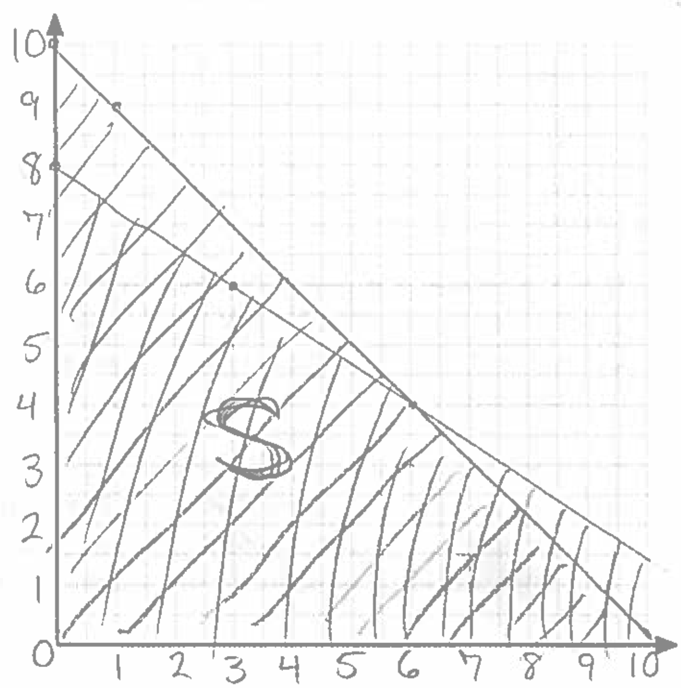
x = boxes of decorations
y = boxes of dinnerware

$x+y \le 10 \rightarrow y \le 10-x$

$100x+150y \le 1200$

$\hookrightarrow \frac{150y}{150} \le \frac{1200}{150} - \frac{100x}{150}$

$y \le 8 - \frac{2}{3}x$



✓ **Self Assessment:**

Rate your level of understanding:

1 – confused  2 – somewhat understand it  3 – completely understand it

Questions?: ______________________________________________

## Calculator Work:

You can use your calculator to help with each of the following things:

1) Graphing lines
2) Finding where lines intersect
3) Finding equations of linear functions
4) Graphing lines

**Notice that there are five buttons across the top of the calculator right below the display screen.**

**These buttons are labeled**
**[Y=]  [WINDOW]  [ZOOM]  [TRACE]  [GRAPH]**

**Before you can graph with the calculator, you must enter the equation by pressing the [Y= ], also called the [F1], button. If the calculator has been used before, the calculator will show the equation of the previous graph entered in the calculator. New or cleared calculators will show only the basic graph menu as shown below.**

```
 Plot1 Plot2 Plot3
\Y1=█
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```

**If the graphing component of the calculator has been used before, then any previous graphs will be listed in Y1=, Y2=, etc. For any of these equations that may need clearing, use the down arrow to move down to whatever lines need clearing, and press [CLEAR] for each one.**

**Now, use the arrow key (if necessary) to return to the line with Y1=, and type in the new equation to be graphed, as illustrated in the following examples. Before beginning, find the second button in the second column [X, T, θ, η], which means "*x*-variable." When you type a variable in order to draw a graph, this is the button to use!**

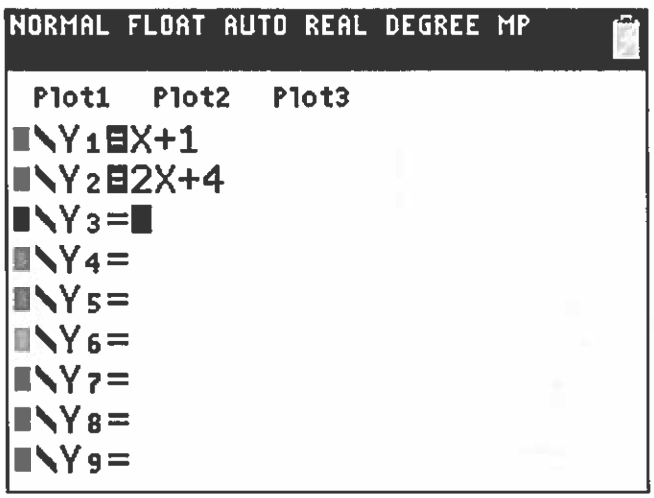
**Once you have entered the equation you wish to graph, press (F5 GRAPH). The graph of your line should show up on your screen.**

2) Finding where lines intersect

Find the intersection of the following functions:
y = x + 1
y = 2x + 4

Solution:

• Press [Y=] to display the Y= Editor.
• Press [X] [+] [1] [ENTER].
• Press [2] [X] [+] [4] [ENTER].




• Press [GRAPH] to display the graphs of the two functions
• Press [2ND] [CALC] [5].
• When *"First curve?"* is displayed, press [▲] or [▼] if necessary to move the cursor to the first function.
• Press [ENTER].
• When *"Second curve?"* is displayed, press [▲] or [▼] if necessary to move the cursor to the first function.
• Press [ENTER].

**NOTE:** The calculator requires that a first and second curve be selected in case there are more than two functions being graphed at one time. This is to specify which two functions to find the intersection of in that case.

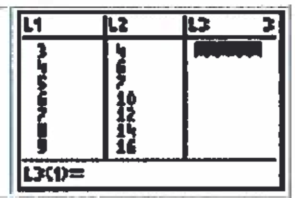
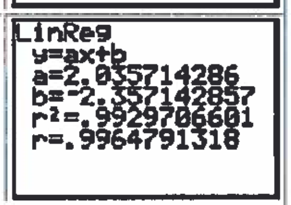
• When *"Guess?"* is displayed, use [◀] and/or [▶] to move the cursor to the point that is the guess as to the location of the intersection.
• Press [ENTER].

**NOTE:** The calculator requires that a guess be made in case the functions being graphed intersect more than once. This is to specify which intersection of the two selected functions to find in that case.

3) **Finding the equations of linear functions**

Example: Create the lists L1=3,4,5,6,7,8,9 (which will represent the x-values) and L2=4,6,7,10,12,14,16 (which will represent the y-values). Use these points to find the line of best fit.

Before you find the line of best fit it is useful to be able to see the points plotted in what is called a scatter plot. The TI-83 will plot these points. Make sure that there are no functions in the Y= list.

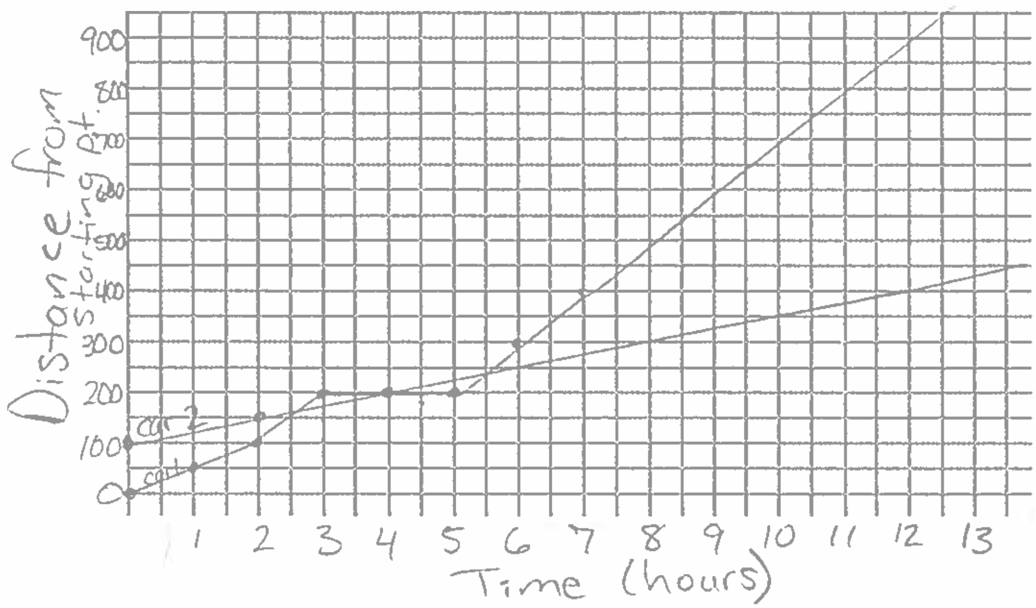
| | |
|---|---|
| Create L1 and L2. |   |
| Go to STAT CALC 4. |   |
| Press ENTER and you will see this screen. |   |
| Now press ENTER again to get the equation of the line. |   |

Name: Key Date: ______________

CW 3.6

1. Two cars are travelling north along a road. The first car travels at a constant speed of 50 mph for two hours, then speeds up and drives at a constant speed of 100 miles per hour (mph) for the next hour. The car then breaks down and the driver has to stop and wait two hours for someone to come fix it. When it is fixed, he drives recklessly at a constant speed of 100 mph. Car 2 started at the same time that Car 1 starts, but the second car starts 100 miles north of Car 1 and travels at a constant speed of 25 mph throughout the trip.

a. Sketch the distance versus time graphs for Car 1 and Car 2 on the graph below. Start with time 0 and measure time in hours.




b. Approximately when do the cars pass each other (estimate by looking at the graph)?

(2.75, 175)
(4, 200)
(5.4, 240)

c. Tell the story of the graph from the point of view of Car 2. What does the driver of Car 2 see along the way? Be sure to mention what they see and when they see it!

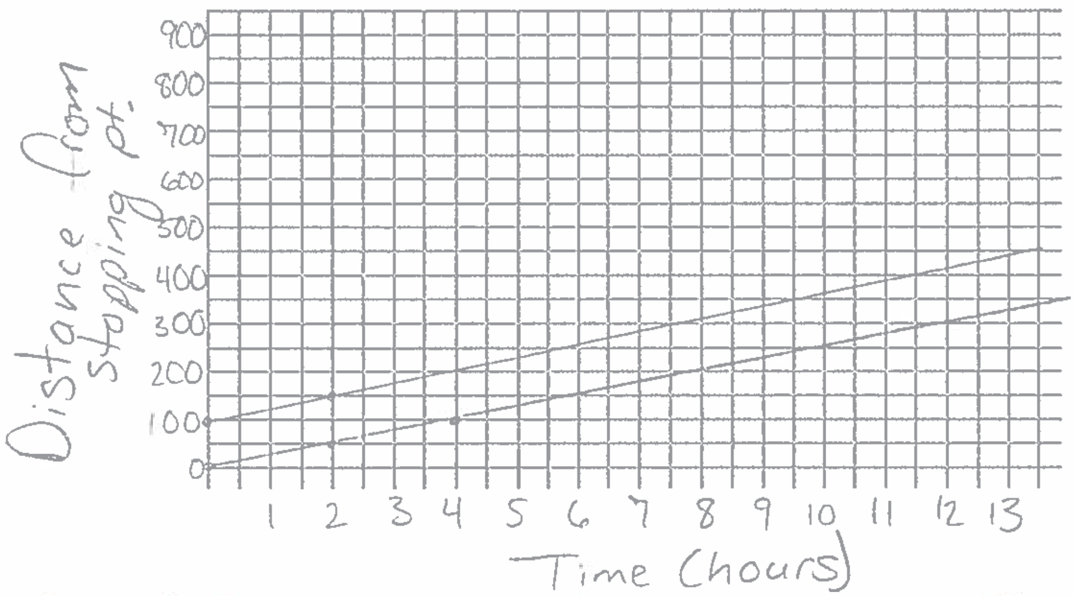
I will drive 25 mph throughout my trip. After driving for about 2.5 miles, a car passes me. After 4 miles, I see the car that passed me broken down on the side of the road. After about 5.5 miles, the car passes me again.

2. Suppose that in problem 1, Car 1 travels at the constant speed of 25 mph for the entire trip. Sketch the graph of distance versus time for the two cars.

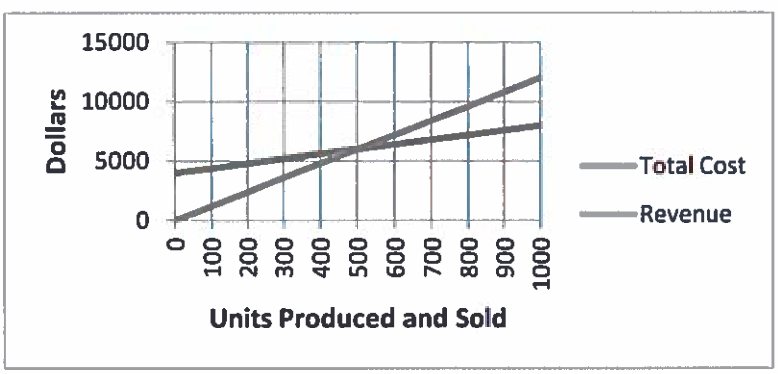
-Do the cars ever pass each other this time? no

-What is the linear equation for Car 1 in this case?

↳ $y=25x$




3. The following graph shows the revenue (income) a company makes from selling clothing items and the total cost (including overhead, maintenance of machines, etc.) that the company spends to make the various items of clothing.




a. What is the meaning of the point (0, 4000) on the total cost line?

When no revenue is produced, the cost is \$4,000

b. What are the coordinates of the intersection point? What is the meaning of this point in this situation?

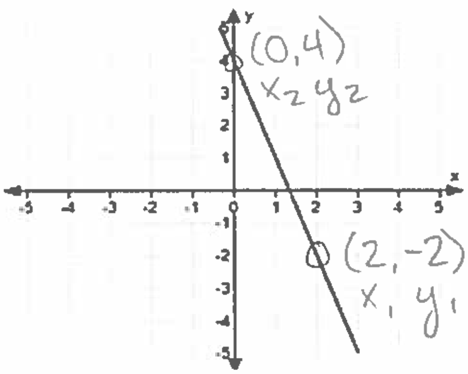
(500, 6000) this point is where the revenue equals the cost

c. Create linear equations for revenue and total cost in terms of units produced and sold. Verify the coordinates of the intersection point by plugging in to the equations that you created.

$y = 12x \leftarrow \frac{6000-0}{500-0} = \frac{6000}{500} = 12$

$y = 4x + 4000 \leftarrow \frac{6000-4000}{500-0} = \frac{2000}{500} = 4$

4. Consider two linear equations. The graph of the first equation is shown. And a table of values satisfying the second equation is given. What is the solution to the system of the two equations?




$\downarrow$

$y = -3x + 4$

| $x$ | −4 | −2 | 0 | 2 | 4 |
|---|---|---|---|---|---|
| $y$ | −26 | −18 | −10 | −2 | 6 |

$\frac{4+2}{0-2} = \frac{6}{-2} = -3$

Algebra

Unit 3 Review

Name: Key

Date: ____________

1) Bobby is selling t-shirts and pants for his local school fundraiser. The t-shirts cost \$5 and the pants cost \$10. He wants to make at least \$200. Create an inequality that fits Bobby's situation AND graph the situation.

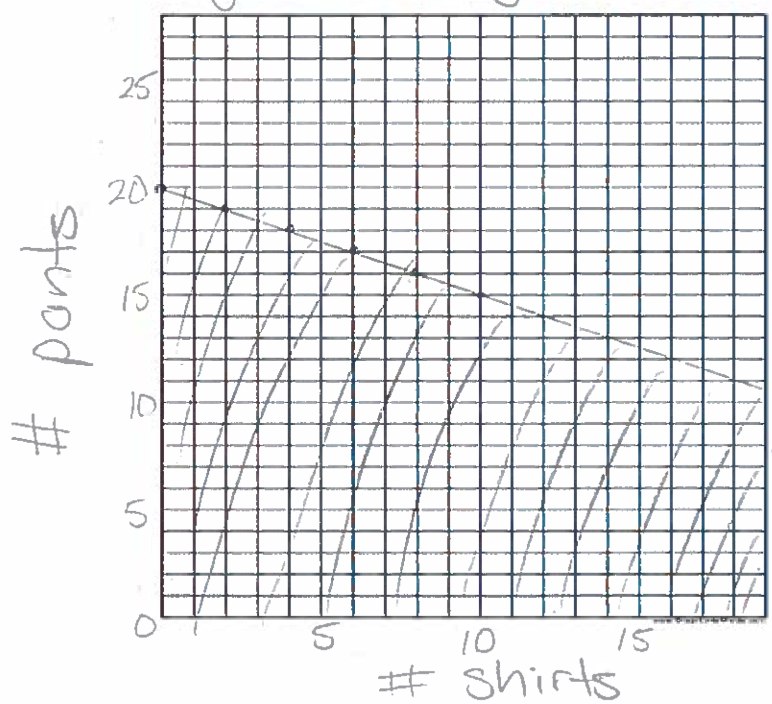
a. What is one possible combination of pants and shirts that will fit Bobby's solution set?

20 t-shirts, 10 pants

b. Do all values of pants and shirts fit? Describe why or why not.

no; some might not give \$200

$$5x + 10y \geq 200$$
$$-5x \qquad -5x$$
$$\frac{10y}{10} \geq \frac{200 - 5x}{10}$$
$$y \geq 20 - \frac{1}{2}x$$




2) Zach wants to buy a combination of pizza and soda. 10 items total were purchased. Soda costs \$1.50 and pizza costs \$2.00, and he has a total of \$18.00 to spend. How many of each item does he end up purchasing?

$$1.50x + 2y = 18$$
$$x + y = 10 \rightarrow y = 10 - x$$

$$1.50x + 2(10 - x) = 18$$
$$1.50x + 20 - 2x = 18$$
$$+20 - .5x = 18$$
$$-20 \qquad -20$$
$$\frac{-.5x}{-.5} = \frac{-2}{-.5}$$
$$x = 4$$

$$x + y = 10$$
$$4 + y = 10$$
$$-4 \qquad -4$$
$$y = 6$$

4 sodas
6 pizza

3) Functions:

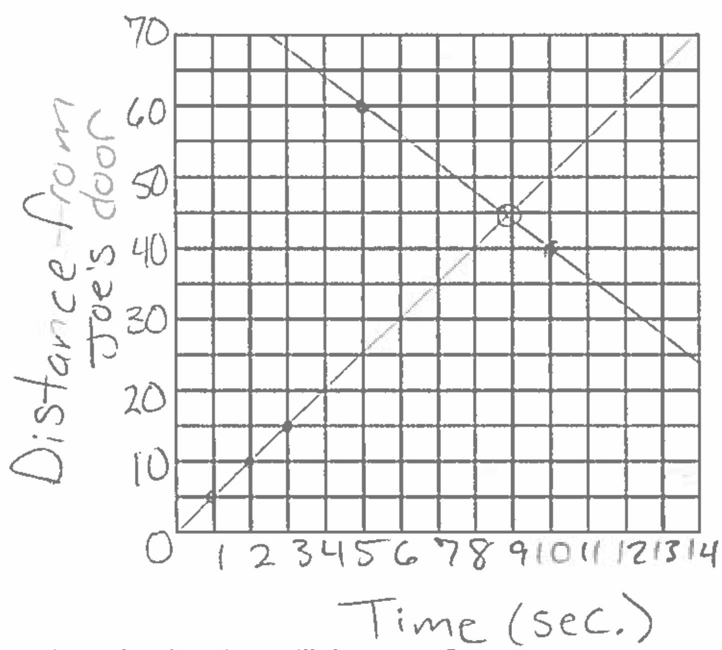
a. Draw an example of a quadratic function, and describe where you may see it in real life.

jumping

b. Draw an example of an exponential function.

4) Joe and Kathy live at opposite ends of the hall. Joe's door is 80 feet from Kathy's. They walk towards each other, Joe moving at 5 feet per second and Kathy moving at 4 feet per second.

a. Graph both Joe and Kathy's distances, in feet, from Joe's door vs. time in seconds.




b. At approximately what time will they meet?

about 9 seconds

c. Find the equations for both Joe and Kathy.

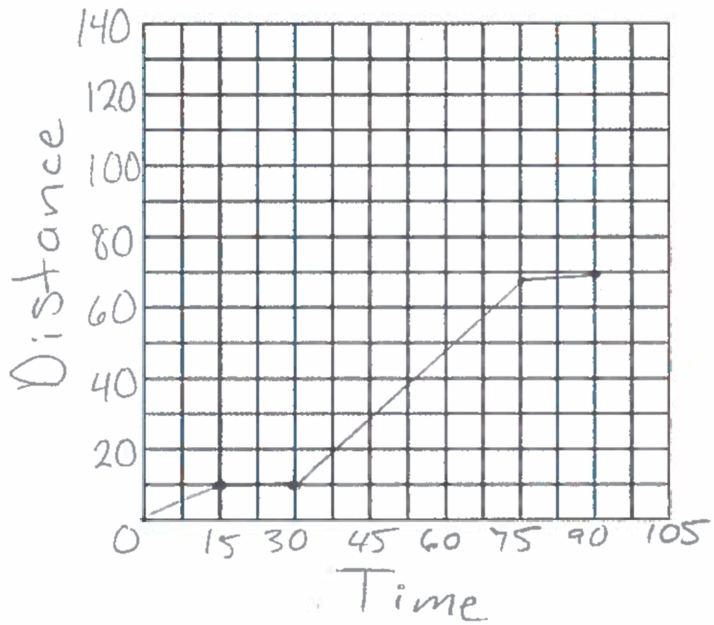
$5x$ $\quad$ $80 - 4x$

d. Using algebra, verify that your answer to part (b) is correct by finding the EXACT time when Joe and Kathy meet.

$$5x = 80 - \cancel{4x}$$
$$+4x \qquad \cancel{+4x}$$
$$\frac{\cancel{9}x}{\cancel{9}} = \frac{80}{9}$$
$$x = 8.\overline{8} \text{ seconds}$$

5) Tom and Sally are going to the mall. At 10 AM, Tom leaves his car and drives at a rate of 40 miles per hour. After 15 minutes, he gets stuck in traffic for another 15 minutes. Then, he continues on his journey for 45 minutes at a rate of 50 miles per hour. When they arrive, they drive at a rate of 5 miles per hour in the parking lot for another 15 minutes looking for a place to park.

a. Draw a graph that shows the distance vs. time for Tom's trip to the mall. Remember to label your axes with the units you chose and any important points (home, mall, etc.)



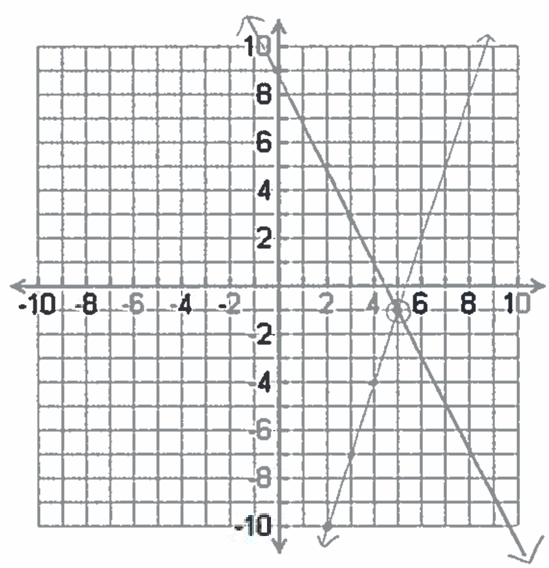

b. What was the total distance that Tom drove to the mall? How much time did it take him?

68.75 miles 90 minutes

6) Graph the lines below, and find their intersection point graphically.

$2x + y = 9 \longrightarrow y = 9 - 2x$
$3x - y = 16 \longrightarrow y = 3x - 16$

$(5, -1)$



7) Solve the following system algebraically (use either substitution or elimination).

$$\begin{cases} 3x + y = 9 \\ 5x + 4y = 22 \end{cases} \rightarrow y = 9 - 3x$$

$5x + 4y = 22$
$5x + 4(9 - 3x) = 22$
$5x + 36 - 12x = 22$
$-7x + \cancel{36} = 22$
$-\cancel{36} \quad -36$
$-7x = -14$
$\frac{-7x}{-7} = \frac{-14}{-7}$
$x = 2$

$3x + y = 9$
$3(2) + y = 9$
$\cancel{6} + y = 9$
$-\cancel{6} \quad -6$
$y = 3$

$(2, 3)$

8) Solve the following system algebraically (use either substitution or elimination).

$$\begin{cases} 2y - 4x = 2 \\ y = -x + 4 \end{cases}$$

$\rightarrow \cancel{2y} = 4x + 2$
$(y = -x + 4)\,{-2}$: $-\cancel{2y} = 2x - 8$
$0 = 6x - \cancel{6}$
$+6 \quad +\cancel{6}$
$6 = \cancel{6}x$
$\frac{6}{6} \quad \frac{\cancel{6}}{\cancel{6}}$
$x = 1$

$y = -x + 4$
$y = -1 + 4$
$y = 3$

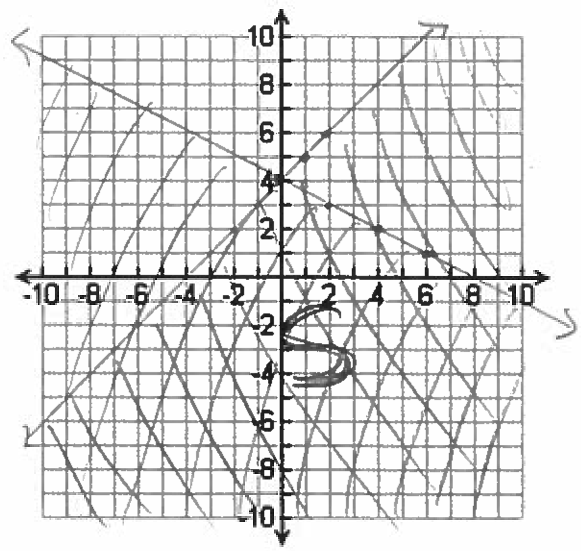
$(1, 3)$

9) Graph the following system of linear inequalities. **Name one point in the solution set, and one point not in the solution set.** $\rightarrow (-8, 4)$ $\quad (0, 0)$

$x + 2y \le 8 \rightarrow \frac{2y}{2} \le \frac{8 - x}{2}$

$y \le 4 - \frac{1}{2}x$

$y \le x + 4$



Algebra

Name: Key ✓

Unit 3 Exam

Date: ______________

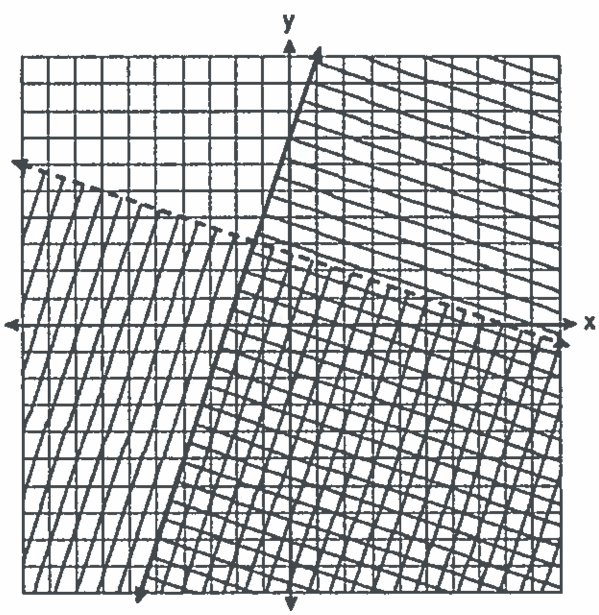
Score: _______ / 75

**Part One - Multiple Choice Questions (24 points total). Answer all questions in this part. Each correct response, with appropriate work will receive 3 points. You may receive 3 points for correct work and the correct answer, 2 points for the correct answer with no work, 1 point for the incorrect answer but appropriate work, and 0 points for the incorrect answer and no appropriate work.**

1. Which of the following situations models a quadratic function?

1) The growth of a population of the local deer population
2) The growth of bacteria in a Petri dish
3) The path of a bouncing ball
4) Rate versus time

2. Which ordered pair is in the solution set of the system of linear inequalities graphed below?




1) (1, −4)
2) (−5, 7)
3) (5, 3)
4) (−7, −2)

3. Simplify the following expression: $(5x^2 - 3x + 5) - 2(x^2 - 8x - 1)$

1) $3x^2 + 13x + 7$

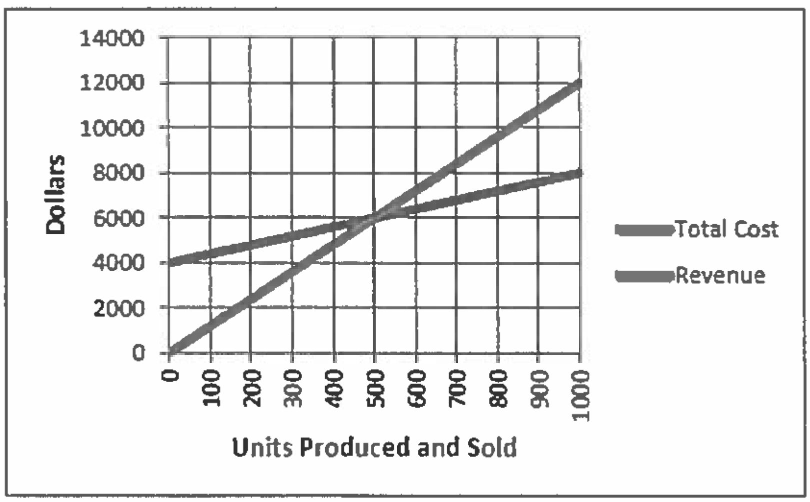
2) $3x^4 + 13x^2 + 7$

3) $7x^2 - 5x + 3$

4) $3x^2 - 11x + 3$

4. Use the graph below:

The following graph shows the revenue (or income) a company makes from designer coffee mugs and the total cost (including overhead, maintenance of machines, etc.) that the company spends to make the coffee mug.




How many units must be produced and sold for the company to make a profit (revenue is higher than total cost)?

1) ( 0, 500 )

2) [ 0, 500 ]

3) [ 500, ∞ )

4) (500, ∞ )

5. Which of the following situations does **not** model a quadratic function?

1) Shooting a basketball

2) The growth bacteria doubling

3) A frog jumping from lily pad to lily pad

4) A girl jumping rope

6. Assume that a bacteria population doubles every hour. Which of the following tables of date, with *x* representing time in hours and *y* the count of bacteria, could represent the bacteria population with respect to time?

a)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *x* | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| *y* | 1 | 3 | 7 | 13 | 21 | 31 | 43 |

b)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *x* | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| *y* | 4 | 6 | 10 | 13 | 16 | 19 | 22 |

c)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *x* | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| *y* | 3 | 6 | 12 | 24 | 48 | 96 | 192 |

d)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *x* | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| *y* | 2 | 6 | 10 | 14 | 18 | 22 | 26 |

7. Find the values that make the denominator equal to zero: $\frac{x-6}{2x(x+5)}$

1) { -5, 2, 0, 6 }

2) { }

3) { -5, 0 }

4) { -5, 0, 6 }

8. Solve and graph the following inequality: $-4 < 6 - 2x \le 8$

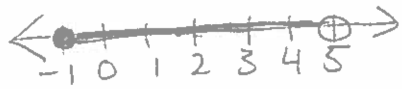
$$\begin{array}{ccc} -6 & -6 & -6 \\ \hline -10 < & -2x & \le 2 \\ \overline{-2} & \overline{-2} & \overline{-2} \end{array}$$

a) In words: x is greater than or equal to -1, but less than 5 $5 > x \ge -1$

b) Set notation: $\{x \mid -1 \le x \le 5\}$

c) Interval notation: $[-1, 5)$

d) Number line:




**Answer all questions in this part. Each correct answer will receive the credits listed. Clearly indicate the necessary steps, including appropriate formula substitutions, diagrams, graphs, charts, etc. For all questions in this part, a correct numerical answer with no work shown will receive only 1 credit.**

9. **(4 points)** Sue needs golf balls and tees before the spring golf season begins. She only has \$42 to spend, so she can't spend more than \$42. If a box golf balls cost \$18 and a bag of tees cost \$2, create the linear inequality that fits Sue's situation **and** find a possible number of box(es) of golf balls and number of bag(s) of tees that Sue could purchase? **(Graph and inequality are worth 3 points, possible solution to inequality worth 1 points.)**

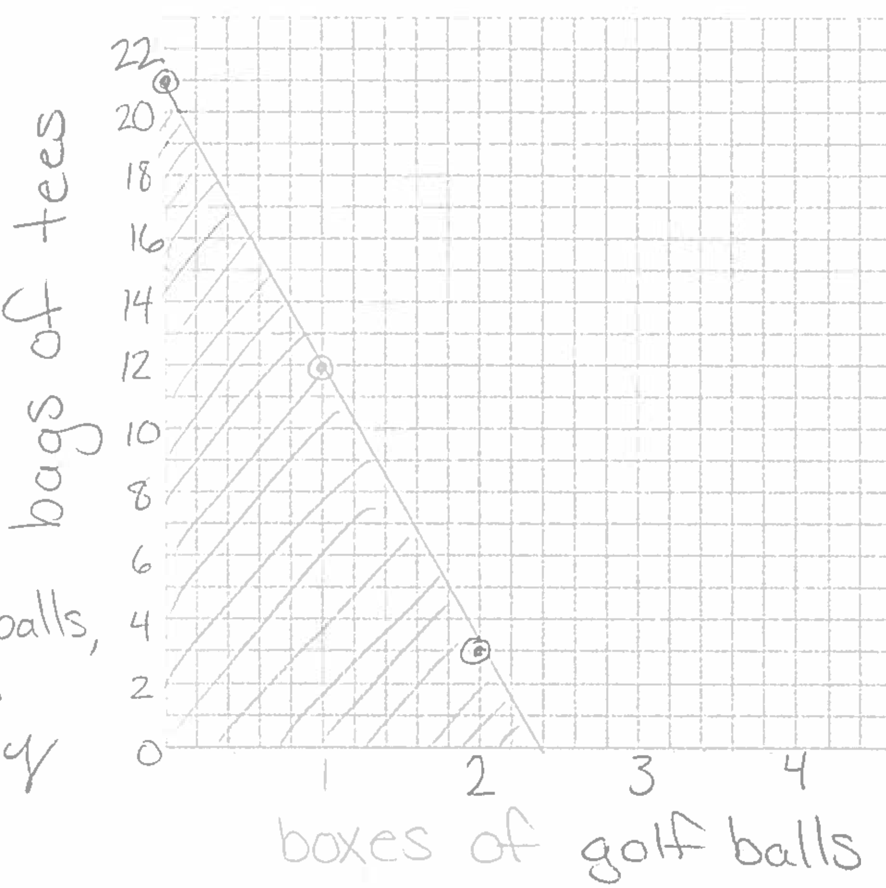
x = # of boxes of golf balls
y = # of bags of tees

$18x + 2y \le 42$

$\hookrightarrow \frac{2y}{2} \le \frac{-18x}{2} + \frac{42}{2}$

$y \le -9x + 21$

1 box of golf balls, 12 bags of tees
→ answers may vary



10. **Students and adults purchased tickets for a recent basketball playoff game. All tickets were sold at the ticket booth—season passes, discounts, etc. were not allowed.**

**Student tickets cost \$5 each, and adult tickets cost \$10 each.**
**A total of \$4500 was collected. 700 tickets were sold.**

a) **(4 points)** Write a system of equations that can be used to find the number of student tickets, ***s***, and the number of adult tickets, ***a***, that were sold at the playoff game. **Solve** this system using whatever method you prefer.

s = # of student tickets
a = # of adult tickets

$a + s = 700 \rightarrow s = 700 - a$
$5s + 10a = 4500$

$5(700 - a) + 10a = 4500$
$3500 - 5a + 10a = 4500$
$-3500 \qquad\qquad -3500$
$\frac{5a}{5} = \frac{1000}{5}$
$a = 200$
$s = 700 - 200$
$s = 500$

$\boxed{\text{500 student tickets, 200 adult tickets}}$

b) **(2 points)** Using your answer from part a, use the number of adult tickets sold and the number of student tickets sold to determine how much more money could have been collected at the playoff game if the student price was kept at \$5 per ticket and the adults were charged \$15 per ticket instead of \$10?

$5(500) + 15(200) = 2500 + 3000$
$= 5500$
$-4500$
$1000$

$\boxed{\$1{,}000 \text{ more}}$

11. Alexus is modeling the growth of bacteria for an experiment in science. She assumes that there are $B$ bacteria in a Petri dish at 12:00 noon. In reality, each bacterium in the Petri dish subdivides into two new bacteria every 20 minutes.

a. Create a table that shows the total number of bacteria in the Petri dish at 1/3 hour intervals for 2 Create a table that shows the total number of bacteria in the Petri dish at 20 minute intervals for 2 hours, starting with time 0 to represent 12:00 noon. The table has been started for you. **(3 points)**

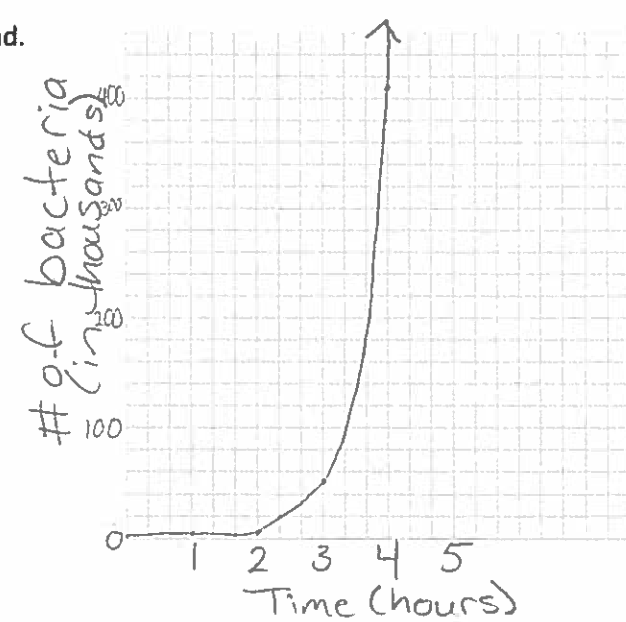
| Time | 0 (12:00) | 1 (12:20) | 2 (12:40) | 3(1:00) | 4(1:20) | 5(1:40) | 6(2:00) |
|---|---|---|---|---|---|---|---|
| Number of Bacteria | B | 2B | 4B | 8B | 16B | 32B | 64B |

b. The equation that describes the relationship between total number of bacteria $T$ and time $h$ in hours, assuming that there are $B$ bacteria in the Petri dish at $h = 0$ is, $T = B(2)^{(3h)}$

If Alexus starts with 100 bacteria in the Petri dish, draw a graph that displays the total number of bacteria with respect to time from 12:00 noon ($h = 0$) to 4:00 p.m. ($h = 4$). Label points on your graph at time $h = 0, 1, 2, 3, 4$. Since she is starting with 100 bacteria, B will be replaced with 100.

| Hours = h | Number of Bacteria = $100(2^{3h})$ |
|---|---|
| 0 | 100 |
| 1 | 800 |
| 2 | 6400 |
| 3 | 51200 |
| 4 | 409600 |

Fill out the table, and graph the values you find.
**(6 points – 3 for table, 3 for graph)**



12. Jacob and his friends are going to Six Flags. At 8:00am, Jacob hops in his car and drives at a constant speed of 30 miles per hour for half an hour to pick up Ricardo. Ricardo isn't ready so Jacob has to wait 15 minutes. The boys drive at a constant rate of 60 mph for 2 hours. When they arrived, there was a traffic jam and the boys traveled at a constant speed of 2 mph for 1 hour.

a. Draw a graph that shows the distance Jacob drove to Six Flags with respect to time. Remember to label your axes with the units you chose and any important points (home, Ricardo's house, etc.) **(4 points)**

0-30

$\frac{30\,mph}{.5h} = 15m$

30-45

0 m

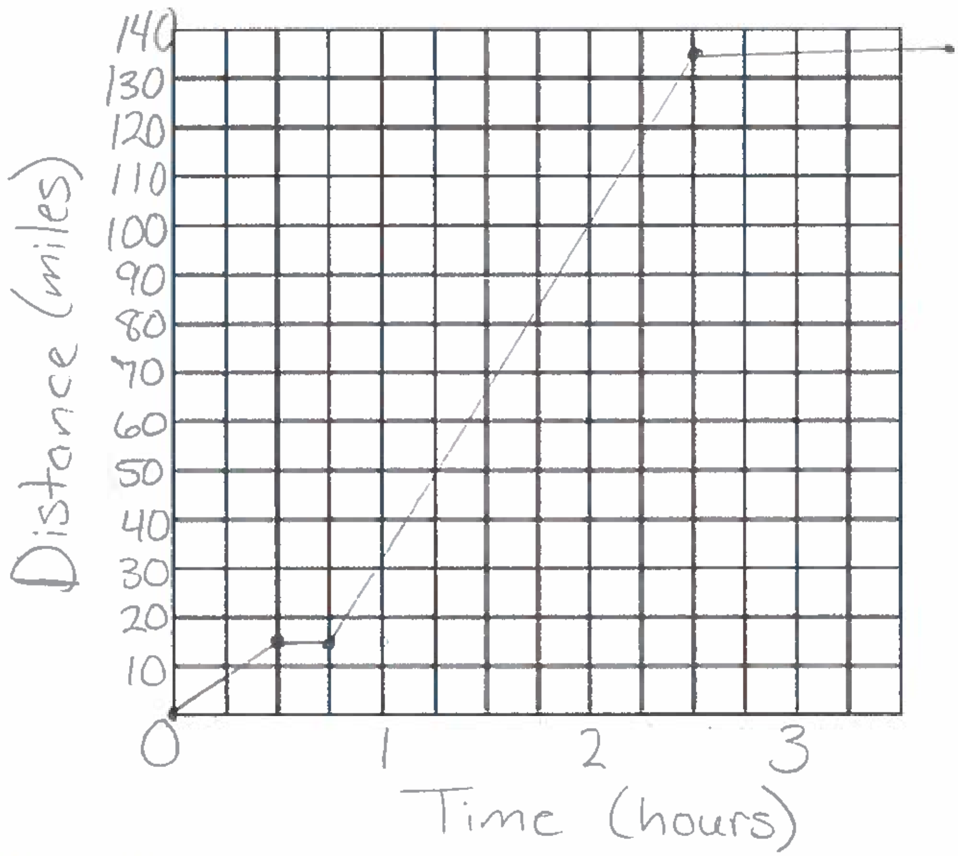
45-2:45

$60 \times 2$

$= 120$ m

2:45-3:45

$= 2m$




b. What was the total distance Jacob drove to Six Flags? **(2 points)**

15+0+120+2

137 miles

13. Solve the following system using the process of elimination: **(3 points)**

$3\,(4x - 3y = 25) \rightarrow 12x - 9y = 75$

$4\,(-3x + 8y = 10) \rightarrow -12x + 32y = 40$

$23y = 115$

$\frac{23y}{23} = \frac{115}{23}$

$y = 5$

$4x - 3y = 25$

$4x - 3(5) = 25$

$4x - 15 = 25$

$+15 \quad +15$

$4x = 40$

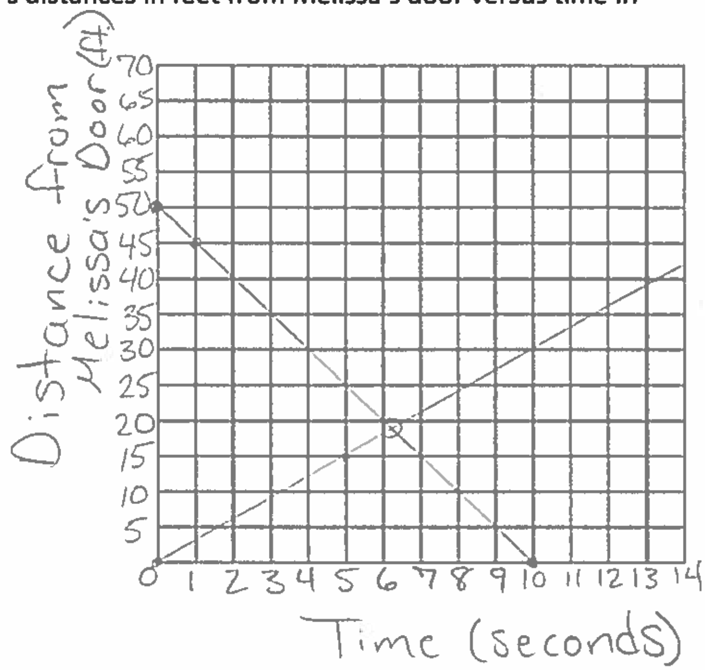
$\frac{4x}{4} = \frac{40}{4}$

$x = 10$

sol.: (10,5)

14. Melissa and Walter live at opposite ends of the same street. Their front doors are 50 feet apart. They each start at their door and Melissa walks at a constant rate of 3 ft/sec and Walter jogs at a steady rate of 5 ft/sec and move towards each other.

a) Accurately graph both Melissa's and Walter's distances in feet from Melissa's door versus time in seconds. **(4 points)**




b) According to your graphs, ***approximately*** what time will Melissa and Walter meet? **(2 points)**

shortly after 6 seconds

→ between 6 & 7 seconds

c) Determine the equations that represent Melissa and Walter's paths. **(3 points)**

$y=3x$ $\quad$ $y=50-5x$

d) Using the equations that you found in part c, determine the ***exact*** time when Walter and Melissa meet. **(2 points)**

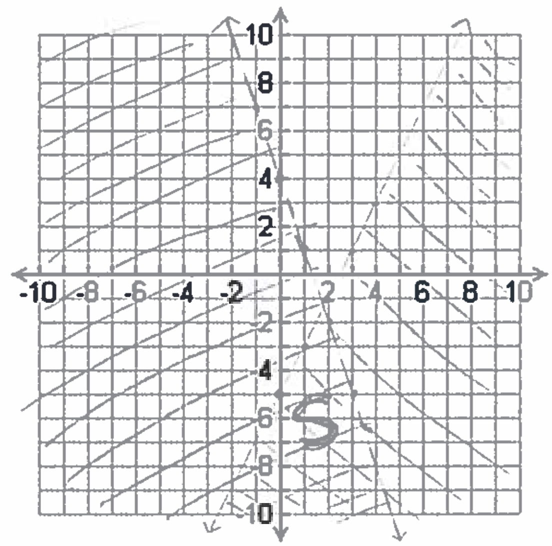
$$3x=-\cancel{5x}+50$$
$$+5x \quad +\cancel{5x}$$
$$\frac{\cancel{8}x}{\cancel{8}}=\frac{50}{8}$$
$$x=6.25$$

$\boxed{6.25 \text{ seconds}}$

15. Graph the following system of linear inequalities. Be sure to label the solution set with an S.
**(4 points)**

$y < -3x + 4$

$2x - y \geq 5$ $\longrightarrow y \leq 2x - 5$




a) Name one point in the solution set **(1 point):** (2, -6)

b) Name one point NOT in the solution set **(1 point):** (0, 0)

} answers may vary

16. a. Graph the system below, and find the intersection point. **(3 points)**

$y = -3x + 6$

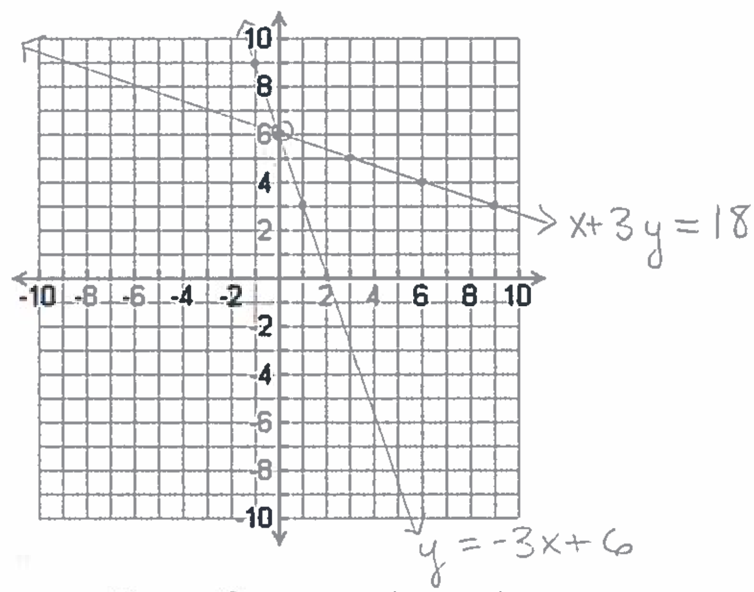
$x + 3y = 18$

$\cancel{x} \quad\quad -x$

$\frac{3y}{3} = \frac{18}{3} - \frac{x}{3}$

$y = 6 - \frac{1}{3}x$

sol.: (0,6)




b. Using substitution, confirm that the system has the solution that you found above. **(3 points)**

$y = -3x + 6$
$6 = -3(0) + 6$
$6 = 6$ ✓

$x + 3y = 18$
$0 + 3(6) = 18$
$18 = 18$ ✓